This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

Trial-and-Error, Gradual Analysis, and Sudden Reorganization

An Experimental Study of Problem Solving

BY
HELEN E. DURKIN

Submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, in the Faculty of Philosophy, Columbia University

ARCHIVES OF PSYCHOLOGY
R. S. WOODWORTH, Editor
No. 210

NEW YORK
May, 1937

Digitized by Google

BF
1
.A67

ACKNOWLEDGEMENT

To Professor R. S. Woodworth, for his sympathetic guidance, and unfailing inspiration; to James E. Durkin, T. E. Jackson, and H. A. Snow, for their assistance with the photography and editing; to all my subjects for their understanding cooperation, I wish to express my sincere thanks.

Digitized by Google

Exchange
Columbia University
Library

NOV 17 1939

TABLE OF CONTENTS

CHAPTER	PAGE
I. PROBLEM AND METHOD	5
A. Definitions	5
B. Origin of the Study	6
C. Object	10
D. Technique	10
II. RESULTS FROM THE SIMPLE SQUARE PUZZLES—TRIAL-AND-ERROR COMPARED TO ANALYSIS	16
A. Preliminary Survey of Results	16
B. Trial-and-Error as a Method of Approach	18
C. Analysis as a Method of Solving	20
D. Comparison of Trial-and-Error and Analysis as Forms of Thinking	25
E. Solutions Combining the Two Methods on the Simple Squares	26
F. Levels of Problem Solution According to O's Degree of Understanding of the Goal	31
G. Levels of Analysis, Based on Degrees of Clearness as to Relation between Pieces and the Goal	34
H. Solutions of the Simple Squares by Sudden Reorganization	35
I. Effect of the Nature of the Problem and the Nature of the Subject on the Method Used in Solving	42
J. Summary of Results of Chapter I	44
III. RESULTS FROM THE TOTAL CROSS PUZZLE—SUDDEN REORGANIZATION COMPARED TO ANALYSIS	47
A. Aims	47
B. Preliminary Survey of the Present Results in Relation to This Part of the Literature	48
C. Detailed Analysis of Cases of Sudden Reorganization	49
D. Variations in the Sudden Reorganization Pattern	66
E. Detailed Characteristics of the "Moment of Illumination"	67
F. Preliminary Survey of Results on Gradual Analysis	71
G. Three Cases of Gradual Analysis	73
H. Summary of Types of Solution	78
I. The Role of Experience	79
J. Summary of Results of Chapter III	80
IV. GENERAL CONCLUSIONS	83
BIBLIOGRAPHY	85

Digitized by Google

The following Abbreviations will be used in this Paper:

T.C. —the final "total cross" puzzle
S.S. —the five "simple square" puzzles
T.E. —trial-and-error
M. —manipulation
A. —analysis
G.A. —gradual analysis
S.R. —sudden reorganization
M.M.—mental manipulation
E. —experimenter
O. —observer

Digitized by Google

CHAPTER I

PROBLEM AND METHOD

A. Definitions

Thinking. Controlled thinking is the X in this problem. It has been assumed to consist of the process or processes that go on implicitly when O solves a problem.

Trial-and-error (1) in its broad sense refers to the exploratory nature of the whole course of a thought movement. This definition is accepted by this paper, but Trial-and-success is suggested as preferable, so that these two senses of the term can be more readily distinguished; (2) in its narrow sense refers to solving by "test" or trial moves of varying degrees of blindness as to the goal, from moving a piece in order to find a relation to the goal, to testing the practicability of a seen relation to the goal. It is in this sense that the term will be used in this paper. As such it is meant to take account of the fact that O's behavior is affected by his interpretation of the goal.

Manipulation is used to refer to the trial moves themselves (a part of the T.E. process).

Restricted Sector of Response (Woodworth) will be used to refer to the M used by an O after its scope has been narrowed down by his having gained a certain amount of understanding of the goal. At each increase in understanding ("insight") we have the sector of his responses restricted.

Insight also has several definitions:

(1) In its result sense of understanding it is not used here except in quotes to show how it might be used in the literature.

(2) In its functional sense, which is not yet well defined, insight is similar to grasping or educing a relation, and is equivalent to each step in analysis, as defined below.

(3) In the sense of sudden recentering it will be referred to as sudden reorganization.

(4) In its broadest sense of a temporal gestalt in which the stimulus and the response are coupled directly, it is not considered here because it involves too complex theoretical interpretations, while we are interested chiefly in fact.

Direction (N. R. F. Maier's term) means a particular way of

Digitized by Google

seeing the material in relation to the problem situation; O's orientation toward the goal.

Analysis is used in this paper to mean observation, recall, and inference about the goal and about the material in relation to the goal.

Gradual Analysis is analysis combined with manipulation giving the effect of gradual progress toward the goal.

Mechanical Analysis (Duncker's term) is analysis starting with the goal and working backward to the given material.

Organic Analysis (Duncker's term) starts with the material or the goal, and works from both ends, meeting in the middle.

Organization or Gradual Organization is equivalent to analysis where no change of direction is involved.

Gradual Reorganization would apply where there is a change of direction which comes about gradually.

Sudden Reorganization applies where the direction is changed suddenly.

B. Origin of the Study

A casual dip into the literature of experimental problem-solving yields a chaotic picture indeed. Deeper search however, reveals that much of the confusion arises from varied attempts to "track down" that elusive process or processes we call thinking. Many terms found useful and appropriate by different authors have, as a consequence, been applied to a single phenomenon.

1. Watt's "aufgabe," Maier's "direction," and Claparède's "resonance" have been used to describe the fact that O's perception of the goal has an effect on his processes, facilitating related ideas and inhibiting unrelated ones.

2. Bühler's "thoughts," Binet's "pensées," Woodworth's "imageless thoughts," Hobhouse's "perception of relations," Spearman's "eduction of relations and correlates," Pillsbury's "inference," Ruger's "analysis," Wertheimer's "centering," and Köhler's "insight" have been used to describe what is probably the principal process in thinking.

3. Wertheimer's "recentering," Poincaré's "illumination," Heidbreder's summation of "spectator behavior," and those definitions of insight which include suddenness have been used to describe the fact that sometimes the whole problem picture changes suddenly for the subject.

4. Selz' "schema," Eidens' "pattern," and all definitions of insight are used to point out the fact that in thinking the perception of

Digitized by Google

the goal and the processes leading to its attainment are combined in some sort of relation or pattern. Whether this is intrinsic or superficial is not agreed upon.

5. The broadest conception of insight is an attempt to express all the factors in a single concept. Even the broadest interpretation of T.E. however is considered by the gestaltists to overlook the connection, but this criticism oversimplifies the T.E. interpretation.

On the other hand, the terms insight and T.E. have been used in several different ways and seem to apply to a variety of phenomena. T.E. has been applied to:

1. Relatively random manipulation of the material without any *definite* idea of the result in terms of the goal, though in hope of finding some relation between it and the material.

2. Less random manipulation which occurs after the subject has seen a general relation to the goal but wants to find a specific relation between one or more parts of his material, or between one part and the goal.

3. Test moves checking a hypothesis when the relation is already clearly seen. In a sense these are merely differences in degree of randomness of the trial move, but when no distinction is made they are nevertheless confusing to the unitiated reader.

Moreover, T.E. is also used to apply to the whole process of solving the problem as well as to a specific process within the thought movement and that does confuse the issue. Thorndike has suggested trial-and-success, and if applied only to this last variety, it would clear up some of the confusion.

Insight has not yet developed a clear-cut definition. Ruger and Alpert often use it simply in the sense of understanding. Duncker uses it to mean penetration of the problem situation, and of the functional value of the material. In this sense it is practically indistinguishable from "seeing relations." Köhler and Yerkes, in their first description of the process, implied sudden reorganization, but in later usage suddenness has come to be regarded as non-essential. In a casual way many more meanings have been attached to the term as Bulbrook* points out.

All this mass of ideas has not yet been synthesized, and offers the student an almost inextricable web. Confusion is heaped on confusion by the controversial aspect of the literature, for the definitions of T.E. offered by gestaltists, and those of insight by their antagonists, do not add to the accuracy of these concepts. Yet this is one

* *Am. J. Ps.*, 1932.

Digitized by Google

of the major controversies, and must be taken into account. Köhler who first made much of the term insight, regards it as the antithesis of T.E. Wertheimer, Duncker, and Norman Maier embrace this view and insist that all thinking is "insightful." But Pillsbury, Heidbreder, and Claparède stress the view that it is of an essentially T.E. character.

The best way to clarify the air is to trace briefly the historical usage of the terms. To this end I quote from Professor Woodworth's manuscript:

Trial and error was perhaps first used by A. Bain. See his *Mental Science*, 1870, pp. 162–3. Its introduction into animal psychology was due especially to C. Lloyd Morgan, *Introduction to Comparative Psychology*, 1894, and *Animal Behavior*, 1900, p. 344. He contrasted trial and error with "perception of relations." Thorndike, 1899, preferred the term "trial and accidental success" and contrasted it as a mode of learning with "learning by ideas." Neither Lloyd Morgan nor Thorndike conceived of it as a purely random series of movements unrelated to any goal. Only the Gestalt psychologists, Köhler, Koffka, and Wheeler have set up that concept of trial and error as a target to shoot at. The definite testing of hypotheses has perhaps not been classed as trial and error. Ruger and Krechevsky contrast the two rather than assimilating them. Ideational trial and error as the procedure in reasoning was suggested by W. B. Pillsbury, *Psychology of Reasoning*, 1910, pp. 188–194, 232. His point was that actual reasoning, as distinguished from subsequent testing of the validity of a conclusion, was a matter of following up various clues, and rejecting those which did not seem acceptable until one was hit upon which appeared satisfactory. He noted also that purely ideational testing of a hypothesis was seldom sufficient to establish its positive value; it usually had eventually to be tried out with material objects. It seems a mistake of Norman Maier (1931) to speak of trial and error as a proposed "explanation of reasoning." It is descriptive, not explanatory. Trial and error is a procedure which is forced upon the subject by his inability to see the way to the goal. If he sees a clear path, there is no problem; and if he cannot see the way he must do some exploring. He may be able to do some of his exploring ideationally. But when we have so described his general procedure we have not explained how he gets his hypotheses nor how he sees that a hypothesis will or will not work.

Historical note on insight. The name insight was used somewhat by Ruger (1910), by Franken (1911), and by Ladd and Woodworth (1911), before Köhler, but with a somewhat more restricted meaning, more in line with ordinary usage. The real beginnings of this discussion are due to Hobhouse, *Mind in Evolution*, 1901, who spoke in terms of perception of relation among objects. He conceived of three evolutionary stages. In the lowest, a relation between objects has an effect upon behavior, a gradual effect such as is seen in some learning, but there is no sign of any perception of the relation. In the intermediate stage, terms in relation are perceived, but the relations are not isolated. In the third and probably exclusively human stage the relations themselves are singled out in perception. Hobhouse called the intermediate stage "practical judgment," and this corresponds to Köhler's insight.

Digitized by Google

Ruger's terms were *analysis* and *conscious variation.* He noted the "flash experience" in which the suddenness of shift from vague to definite direction is specially dramatic. German writers call it the "Aha! experience."

Insight, in ordinary usage, implies a seeing below the surface of things. Köhler, however, gave it rather a more general and less exalted meaning. He said that an ape showed insight when, a stick and a banana being placed adjacent to each other, with the near end of the stick close to the ape's hand, "closure" occurred and the stick was promptly used to pull in the banana. When the stick was placed at the back of the cage insight was unlikely to occur except after experience. "Insight" then, according to Köhler's usage, *consists in any perception of an object pattern including the goal.** It does not require any understanding of the mechanics of a device or of any general underlying principles.

Insight can therefore vary in degree all the way from the most direct and superficial perception of a "detour" up to the discovery of a scientific law. Köhler is not inclined to extend its meaning downward so as to include the perception of a direct path to the goal; but this limitation seems unnecessary and illogical. For if we cannot grant that an animal "sees" a direct path, how can we assume that he sees a detour as a path to the goal?

. . . the suddenness of solution, and the transfer of what has been learned in one situation to a slightly different situation, though valuable as criteria of insight in animals, are not essential to the definition. Typically, indeed, insight occurs at a moment when there is an abrupt change from relatively random to definitely directed behavior. In terms of the "sector" figure, insight is marked by a sudden limitation of the sector of trial and error. Except in very simple, manufactured situations, insight still leaves a sector within which there can be variation of response. Certainly we could not deny the name of insight to cases in which the subject suddenly starts out on the right path to the goal, even though there be a blind alley in the way, which can still cause trouble.

This survey leads us almost inevitably to the same conclusion as do our empirical results, that problem solving is both exploratory and insightful. In fact, T.E. must always imply something more than random activity, for there must be a goal affecting O's behavior. Mere exploratory activity with no particular object in view could scarcely belong under the concept, since without a goal there could be no "error."

Are not both trial-and-error and insight really rough and external characteristics of the whole thought movement, which should be distinguished from those particular points during it, at which thinking seems most active and effective, and where we may find an isolable thinking process? It seems as if the type of problem I am using offers possibilities in the way of a more minute exploration of thinking which, if both points of view and the many terms already used are kept in mind, may help to trace these back to the their empirical sources and thus lead toward synthesis of the whole field.

* Italics mine. H. E. D.

Digitized by Google

What the situation calls for, is an unbiased and detailed investigation, made with the purpose of clarifying the material we already have, and reorganizing it, adding a new hypothesis only if the results compel us. It is such a study I have tried to make. I have, therefore, advisedly, avoided any definite criteria of insight and have merely tried empirically to find what happens, interpreting the facts from an eclectic viewpoint.

C. Object

The object of this study, then, is:

1. To work toward synthesis of the various points of view by experimentally observing, from an eclectic viewpoint, what are the processes and patterns involved in a simple form of the problem-solving type of thinking; and

2. Testing any new hypothesis that the results suggest, particularly with relation to the meaning of the material in the light of the controversy over T.E. and insight.

D. Technique

1. *Materials*

Just a glance at the experimental literature indicated that it would, for my purposes, be best to begin with a very simple level of thinking, for even then it is complex, rapid and not, at each point, clear to the subject. Anything on a more complex level, as verbal, numerical, or even three dimensional construction puzzles, would be extremely difficult to follow through minutely in the attempt to reduce thinking to its lowest terms.

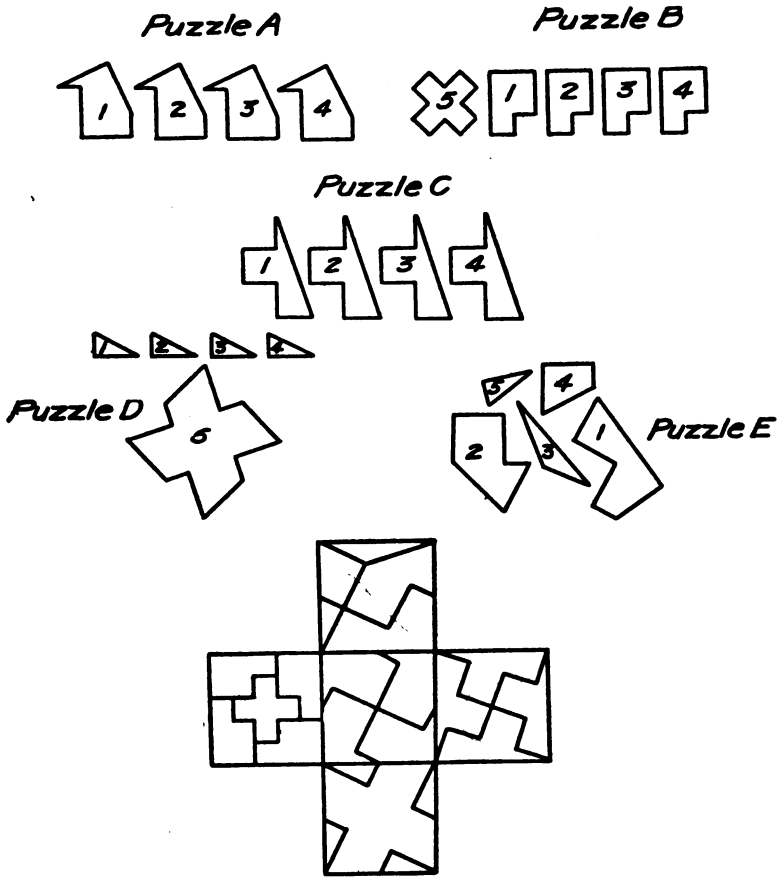
I chose, accordingly, a rather simply organized series of two-dimensional construction puzzles, which seem at first glance to offer a problem only in perception, but whose patterns and form of disarrangement are conceived to necessitate a roundabout process for solution. The subject's problem was to find the roundabout path; mine, the means by which he reached it. This set-up had the further advantages that no factor of skill could cut across the results; that verbal description could be comparatively accurate and easy to follow; and that the situation confronting O at any stage of the solving would be visible and could be photographed.

There were six puzzles in all. Each of five consisted of several (4 or 5) pieces so cut that they could be made into squares (4″ by 4″) or into Malteses crosses. The sixth puzzle consisted of all these pieces to be made into one large Maltese cross. Of the first five puzzles,

Digitized by Google

A, B, C, D and E respectively (see the diagrams) all but B were based at least partly on the diagonal principle, *i.e.*, the apparently straight edges were to be used on the diagonal, and vice versa. All except E were based also on the circular principle, that is, the pieces were to be used pin-wheel fashion. Since they were so presented as to avoid suggesting these principles of construction, and in the case of the diagonal principle to suggest the opposite, these factors contributed to the necessity for finding a roundabout path to solution. The pieces were cut to specification out of bristol board and lacquered black on both sides.

The Simple Square Puzzles as presented



The completed Total Cross Puzzle

Digitized by Google

2. *The Set-up*

O worked at one end of a long wooden table; E sat at the other. Separating them, about midway, was a one-way screen made of rayon. From this screen to the observer, attached to either side of the table and held in a wooden frame, were two large black lacquered sheets of cardboard. They reached about as high as O's head and were meant to isolate O for the purpose of concentration, while the one-way screen served to minimize his consciousness of being observed. A noisy electric fan sounding continuously, masked intercurrent sounds which might be distracting.

3. *Procedure and Instructions*

After E had arranged the pieces of puzzle A in prescribed order (see the diagram) on a large sheet of white cardboard, and covered them with a similar piece, O was asked to come in. E put him as much at ease as possible and then asked him to sit down to the work, told him it was a study of problem solving, and read the following instructions:

This is not in any sense a mental test. I am not interested in how well any individual does, but in the general methods used in solving. Your results will not be evaluated, nor your ability compared to anyone's else. As you solve, please think aloud. Express every idea that comes to you as you work even if it seems irrelevant. Try to tell me also how you feel about it as you go along. My chief interest is to find out as fully as possible just what goes on in your mind as you work. Now, when I say ready, please remove the cover, look at the pieces of the puzzle you will see before you, and try to make a square with them. Before you move any piece, make a plan of what you are going to do. When you have a plan, let me know. Later you will have a chance to work it out. Do you understand, or would you like me to explain any point?

(E then repeated chief ideas, and answered any question.)

As soon as one puzzle was finished, O, with the pieces as originally presented before him, was asked to *retrace* his solution, and any point of interest was discussed.

O was now asked to step outside until E prepared the next puzzle. The same instructions were given for Puzzles B, C, D and E in turn. After Puzzle E, O was allowed to walk down the hall to relax, while E arranged the entire assortment of pieces either as small crosses or in mixed order (see p. 48). Upon his return, E said:

Now, I've given you quite a different puzzle. (This was an attempt to cancel the square-making set.) Put all the pieces together to form a large Maltese cross. Please express verbally every idea that comes to you, in order

Digitized by Google

to help me see just what is going on in your mind as you work. As before, make a plan, before you move the pieces.

This last requirement was not, however, insisted on rigidly. When O did reach a plan, or when he was finished, if he did not formulate a plan, he was asked to retrace.

Variations in method of procedure

During the preliminary experimentation E indulged in many variations for the purpose of finding the best procedure and the most profitable possibilities for investigation. Sometimes the order of presentation, sometimes the arrangement, sometimes the instructions, were varied. The retrace which started merely as an answer to "Is there anything else you haven't told me?" developed into a complete going over of O's processes.

For the final group of 12 subjects the procedure had taken the form described above and was adhered to fairly strictly. However, because of the wide individual differences in solving patterns, E felt free to make further minor variations in procedure if any point seemed worth investigating. Consequently some subjects may have been stopped to answer a question, or given a hint, or allowed to omit working out their plan, if it was correct. Those who solved easily were presented the T.C. as crosses; those who were slow were given it in mixed form. These variations did not affect the processes O used sufficiently to alter our conclusions, and what variations there were, are recorded in the protocols. Only those protocols which, it was felt, were comparable, were used.

4. Records

The moves made in solving supplied a natural and explicit record of the progress of the solution, and were noted as to number and kind. Snapshots were taken at crucial stages. To find out as completely as possible the "how he did it," E asked O to think aloud, and took a full record of his verbal report. The retrace added much valuable material, unreported during the solution, and I strongly recommend it as an integral part of any talking out method. The experimenter must, of course, remain constantly alert to the possibilities of inaccurate report, but with experienced and cooperative subjects who know there is nothing to be gained by appearing smarter than they are, one should be able to gain a fair understanding of what has gone on. E must always interpret the verbal record strictly in light of what O did with the pieces.

Digitized by Google

During the preliminary work it became apparent that unless a professional stenographer were available, it would be better for E to concentrate on the verbal records. It also became clear that it was perfectly possible for E to obtain full and accurate verbal records presenting an undistorted picture of what O had reported, and that these would give more valuable information for thorough study than the time or move records. So that if a choice was forced, E let the time and move records suffer.

Ideal conditions would require talking movies so that any question of interpretation could be checked. Two recorders, one stenographic and one for times and moves and pictures, would be an improvement, and actually necessary for certain types of work with this material, but for my purposes the verbal records seemed adequate.

5. *Subjects*

Preliminary work: 21 observers, 10 of whom were graduate students in psychology at Columbia, the rest college graduates between the ages of 25 and 35, were used to help E:

1. To select from several types of construction puzzles the one best suited to the purpose of this study.

2. To observe their methods in a general way with the idea of finding out if an exploratory study would, in itself, yield any worthwhile information.

3. To try out the plan of comparing the value of different kinds of experience by rotating groups. This method was discarded because of the impossibility of equating groups adequately.

4. To find a definite lead or hypothesis for further study. The most stimulating one was that S.R. always seemed to show some form of background, suggesting that they are more gradual in their development than they seem.

5. To work out the best method of procedure for following up this lead.

Two Master's theses on my material also helped to select the most worth-while lead and determine the procedure on several fine points. These were the work of M. Ross and R. Weinstein, 1933.

Final work on which the discussion of results in this report is based: 28 observers, 12 of whom were college graduates between the ages of 25 and 35, 16 graduate students of psychology at Columbia. Seven of these were given the Total Cross without previous experience; 21 were given experience with the separate squares first.

Digitized by Google

6. *Treatment of Results*

It has to be admitted from the start that experimental evidence in this sort of problem is very difficult to comprehend. The processes involved offer such a multiplicity of reaction patterns that each solution seems, at first, to differ completely from all the others. The general tendencies are almost concealed by the infinite variations of each theme, but with repeated study we can see certain trends clearly enough. To achieve any integrated understanding at all, therefore, we must study the protocols intensively, and from them, draw our conclusions in the light of what other work has shown. The conclusions can be illustrated by the clearest cut cases, but to check their validity we can offer the reader only the complete protocols and a chance to try for himself the solving of the problems. Although not as objective as one would wish, this method does seem suited to the nature of the problem and the results. Surely it would be folly to try to force the data into quantitative form.

Digitized by Google

CHAPTER II

RESULTS FROM THE SIMPLE SQUARE PUZZLES—TRIAL-AND-ERROR COMPARED TO ANALYSIS

(Orientation as to results—a preliminary survey based on intensive study of the protocols and observation of the Os at work.)

A. Preliminary Survey of Results

A single reading of the protocols as a whole reveals the zigzag, exploratory course of solving. There are always trial moves, and progress seldom advances in a straight line like a geometrical theorem. In other words, it has in this sense a T.E. character. More careful analysis, however, shows also that no response to the material is entirely at random. The O does not throw the pieces across the room, nor stand them on end. He does something related, however faintly, to his goal. The T.E. is limited to a certain "sector" of his "repertory of responses" to use Woodworth's expression. Furthermore, only the rarest O solves without seeing the relation of his material to the goal, if only to the extent of recognition. His conduct, in this sense and to this degree at least, is "insightful." Yet to denote puzzle solving as insightful or as T.E., or even as both, is superficial, for it fails to take account of the fact that at certain points in the course of the whole thought movement thinking seems to be more active and effective, and of the fact that some solutions lean very much more heavily in one direction, some in the other. Nor does it cover that interesting variety of solving in which the basic relationship seems to "burst" in upon the O in a sudden dynamic readjustment of the field.

Assuming for the present, then, the zigzag and insightful characteristics of the whole thought movement, we must ask the more fundamental question "What processes lead to the ultimate comprehension of the crucial puzzle relationship?"

Since we are dealing with such very simple material in this study, we find some cases in which one process does the whole job, so to speak, and is consequently fairly well isolated.

1. In at least 10 cases O finds the relationship by M., attending to the goal only in a general way and concentrating on the pieces.

Digitized by Google

These he moves before he sees what the resultant relation to the goal will be. Eventually he recognizes the correct move, solving the puzzle by hindsight. We know that he must have attended to the goal idea somewhat or he could not have recognized it. On the other hand, we surmise that this attention was diffuse, for often the correct move is not recognized till the second or third time it appears. We know, also, that the final recognition of the needed relation was at least as, if not more, important than the manipulation. Since finding the relation to the goal requirements depended primarily on trial moves, T.E. seems the most appropriate term to apply to this method of solving, which is thus distinguished both from Trial-and-Success (the exploratory characteristic of the whole thought movement) and from Analysis described below.

2. Another way of finding the basic puzzle relation necessary to solving was that of making observations, or inferences, or both, about the goal and about the material in relation to the goal, centering attention consistently on the specific goal needs. In doing this, O moves the pieces *after,* and *because* he sees, or thinks he sees, a relation between his moves and the goal. Hence we are dealing with foresight. Since O depends for progress on analysis of the problem situation and has a reason for each move he makes, it seems justifiable to call this process analysis or reasoning. Of the two, analysis seems the less controversial choice.

3. O may also come to see the relation more directly, so that he feels, albeit incorrectly, that the solution came from outside himself and that the work done by him up to that point accomplished nothing. At one moment he does not see the relation, then in the next, he does. Quite suddenly the picture is changed. This may occur directly, on a very simple level, as it does in any immediate solution; or as a result of a physically caused shift of attention based on an eye, head, or body movement; or it may occur at a more complex level as a result of one or more observations, recalls, or inferences which were out of focus in relation to the goal at the time they were made; or these may have been made when O's attention was general; or been taken for granted; or have come in such rapid succession and so fleetingly that O was not fully aware of them. In all cases, he does not realize the part they play in bringing about the solution by a S.R.

In order to understand the basis for these conclusions, we must now turn to the protocols.

Digitized by Google

B. Trial-and-Error as a Method of Approach

E's attention was first drawn to T.E. as a distinct mode of approach by the frequent comments the Os made about manipulatory behavior. Many of them voiced the unsolicited but interesting opinion, when they were engaged in M., that this sort of activity is "what thinking is not." In most cases they reached a successful solution that way although not without the important additional process of recognition. E could, moreover, appreciate their meaning in terms of their activities. They seemed to feel an urge, at the start, just to move the pieces "without thinking about them," and again when they were stumped. This apparently aimless behavior seemed to be a path of least resistance for them and to judge by the records profited them but little. They did not feel, and E did not see, progress during these periods. Let me quote:

H.W. says about his random moves "I'm only playing now" and again, "Just playing, don't see it" and "want to play around but feel it isn't the thing to do."

M.G., in doing the T.C., "I seem to use more overt T.E. than the first time. I knew the pieces would fit so I didn't try to think out the relation again. Didn't see the relation clearly (this time) after having grasped it (last time) I neglected it. It seemed to stay in the background—I paid no more attention to it." Consequently, he took more moves to do it the second time although the principle of the puzzle had transferred.

J.B.C. on B says "I like to just move the pieces rather than figure it out." And on the test "My way of going at things is slap dash.—I don't stop to think about it unless I get stuck."

H.B. on D, "no attempt to see the relation of the little parts in detail, fell back on M. for that."

F.D., "thinking is really planning instead of aimlessly putting the pieces together. If I didn't think I would put pieces together for hours."

H.A., "so dumb—much nicer not to have to move them—didn't want to play with it instead of thinking."

In how far does what they say seem to be true? If we follow through the protocols in which such remarks occur, we find that at these points O does seem, almost completely, to have lost track of the goal. If O carried this sort of thing to its logical conclusion and lost all sight of his goal, he would, indeed, go on "for hours" without progress. But as long as he keeps the idea of the goal in the background, recognition is possible and eventually occurs. We conclude that O is referring to M. and not to the whole T.E. process, which includes reference to the goal, and seeing the crucial relation.

What is the experimental evidence about T.E. as a method of solving? It is rarely used throughout a whole puzzle, but when it

Digitized by Google

is, it is slow and inefficient, seeming to justify the opinions quoted above. However, in spite of the method, the problem is eventually solved, but not till the basic relationship of the puzzle is recognized. Thus we bring into high relief the difference between mere manipulation of the material and M. guided by O's idea of the goal, which we have called T.E. M. is merely the most obvious of O's responses in a T.E. solution.

Let us examine in detail such a solution by T.E.

Protocol 1—E.V.O. on *Puzzle A*

Plan: 2 minutes

1. Oh, my word (laughs in an embarrassed way).
2. ——— I don't see anything ———.
3. ——— can make no plan till I touch them ——.
4. —— I'll have to move them.

Solution: 8 minutes

26 Moves	*Remarks*
Remarks 1–4 are accompanied by M. during the long pauses.	1. ——— E* —— "I can't talk ———.
	2. ——— don't see how ———.
	3. —— feel warm ——— laughs ———.
At 5 lifts one up into the air and examines it (M.).	4. ——— have no idea ——.
	5. —— must stop and try to think.
Another series of quick moves, one of which is right but not recognized (M.).	6. ——— don't think I can do it.
	7. ——— feel ashamed ———.
Another series of rapid moves (1 correct unrecogn.) (M.).	8. —— E "you had it once" O "Yes, there were 2 that went together perfectly —— but can't repeat it."
Puts 2 together wrong but adds third correctly, recognizes it, and very slowly; the last 2 moves are correct (foresight).	9. ——— E* "Just sitting here stupidly just moving pieces —— a vain attempt to do it without thinking ———."
	10. ——— thinking mostly that I'm stupid.
	11. ——— Oh, I see it now (recognition) (after the correct move occurs for the 3rd time).

Retrace:

I didn't think —— just luck —— found two edges of the same length on a slant. Now I can see that if you stopped for a plan, you could see that they were cut the same way; if you arranged the straight edges, the points would fit together inside. Did last slowly because thought it didn't fit accurately enough. (The retrace gives a hint as to how deep the penetration at the moment of recognition was.)

Conclusions from Protocol 1:

This solution is fairly typical of a group of "unthoughtful" appearing solutions. Certain of its characteristics strike us, and they are, on the whole, common to the group. We notice:

* E* means that during a pause, indicated by ——— E asks O what he is thinking about. The quotation which follows is O's answer.

Digitized by Google

1. The time and error scores indicate the slowness, the laboriousness, and the inefficiency of this type of approach.

2. O's aim seemed to be to match sides of equal length—so we know that O saw relations between the pieces, but

3. There is every indication that she did not see what relation each move would have to the goal till after the correct move was recognized. Each move was made before O saw the reason for it.

4. We are dealing, we may conclude, with hindsight, since the crucial relation was grasped by recognition.

5. Since the correct move was recognized we can assume that O attended somewhat, at least, to the idea of the goal. That attention to goal was diffuse and remote rather than concentrated is suggested by the fact that the correct move was not recognized the first time it occurred.

6. Her remark "I see it now" indicates that she saw the relation, and the fact that the next two moves come by foresight bears this out.

7. The verbal report was slight, sketchy and not closely connected to the moves O made. Many of these occurred in rapid succession during long verbal pauses. Since there was no reason to doubt O's cooperativeness we may suppose that the relevant mental content during T.E. is slight.

8. O did not analyze verbally either the goal nor the material in relation to the goal—nor was such analysis implied.

9. O voices the opinion that this sort of "blind" manipulation is what thinking is not, when she says "Just sitting here stupidly, a vain attempt to do it without thinking."

10. The disruptive effect of the self-conscious attitude is noticeable.

Approximately the same characteristics appear in many of the solutions and in certain "dull" periods of others. They seem to depend chiefly on trial moves made before the reason for them in terms of the goal is seen; hence the term T.E. seems to describe them most adequately. In a cursory survey, similar cases are summarized on the following chart, which has been made by listing the characteristics as found in Protocol 1 and comparing each of the other solutions on each point.

C. Analysis as a Method of Solving

M.M.E.'s work on Puzzle A is a typical example of solving by analysis and yields a suitable case for minute study of the method. It contrasts vividly with Protocol 1.

Digitized by Google

CHART.—ANALYZING THE OUTSTANDING CHARACTERISTICS OF T. E. SOLUTION

Subject	*EVO on Puzzle A*	*EVO on Puzzle C*	*E W on Puzzle E*	*La on Puzzle A Solution*	*Whe on Puzzle A*
1. Time occupied	10′	8′	slow	slow	5′
2. Number of moves	26	12	many (no record)	36	30
3. Moves made before relation to goal is seen	all but last 2	all but last 2	all but 1st 2	all but last 2	all but last 2
4. "Hindsight"-recognition of relations after move	yes	yes	yes	yes	yes
5. Amount of foresight	last 2	last 2	last 2	last 2	last 2
6. Verbalized analysis of goal	no	no	no	in plan only but may	no
7. Verbalized analysis of pieces	no	no	no	have had effect	no
8. Attention centered on pieces	yes	yes	yes	yes	yes
9. Attention centered on idea of goal needs	no	no	no	no	no
10. Apparent attitude undirected search	yes	not clear	yes	no	not clear
11. Attitude-directed search	no	not clear	no	yes	not clear
12. Sudden solution S, gradual solution G	S	G	G	S	S
13. Nature of verbal report	In all cases meager and disjointed				
14. Large proportion of moves to inferences	yes	yes	yes	yes	yes
15. No. inferences	none	none	none	none	none
16. Verbal report on O's feeling about the solution	"stupid"	.....	"very empty"	"really going to work at random"	.....

Digitized by Google

CHART—(*Continued*)

	Ea on A Solution only	*La on C Solution only*	*Sch on A Solution only*	*Do on C*
1	3′	3′	10′	slow
2	33	34	30	10
3	most	most	most	most
4	except last only	except last 2	except last 2	except last 2
5	last piece	last 2 pieces	last 2	last 2
6	slight	slight	no	no
7	a slight attempt in both these after moves made		no	no, except after moves
8	yes	up to 4	yes	yes
9	no	after 4	no	no
10	yes	up to 4	yes	yes
11	no	partly	no	no
12	G	S	G	S
13	In all cases sketchy and disjointed			
14	yes	yes	yes, more jerky than rapid	yes but not rapid
15	few	few	none	none
16	"not thinking anything at this point."	"by accident"	"it just seemed to fit"	"just fitted 2 by accident."

Protocol 2, M.M.E. on *Puzzle A*

Plan: 1 minute

1. Well, all same—pause—yes, all same.
2. Doesn't look bad—smiles.
3. Just seeing which is the probable corner (A implied).
4. Obviously longer corners (A implied).
5. Yes, I'll take a crack.

Solution: 13 seconds

5 Moves	*Remarks*
Immediately put 2 together correctly, then 2 more, which he turned upside down and fitted in. No errors.	"I licked that by inspection."

Retrace:

Since a square was called for a certain edge must be a corner. Saw by inspection that if I used the short side as corner the longer would not fit in with the rest of the pattern. Also could see that the 2 short sides would fit together. Can do same for other 2 and turn upside down. No feeling, because

Digitized by Google

too simple. Absolutely certain before moving a piece. The moving of the pieces was entirely unnecessary to the solution. Did it by inspection.

Conclusions from Protocol 2:

What are the obvious characteristics of this solution?

1. Its brevity and the errorless score indicate the efficiency of the method used.

2. His remarks are mostly in direct relation to the moves he plans to make, and there are no long pauses.

3. The result of each move in relation to the goal is seen before the move is made, so we are dealing here, with foresight. This is also plain from his errorless solution, and his remark "I licked that by inspection."

4. Remarks 3 and 4 show that O is analyzing his material. They imply that inferences have been made as to the construction of the material, and as to the goal needs, although only the result of them has been verbalized.

5. It is a good example of the short-circuiting which goes on in thinking, for the obvious stages are taken for granted and simply skipped over. The retrace backs this up. There he gives the rest of the picture. "Since a square was called for a certain edge must be a corner. I saw by inspection that if I used the short side as a corner, the longer side wouldn't fit with the rest of the pieces."

6. O's attention is centered on the goal needs persistently. Consequently he is not upset by the necessity of using the pieces so that the apparent diagonals become the verticals and vice versa. Os who attend chiefly to the pieces, leaving the goal in the background are usually very much troubled by this. This O, however, has "jumped the hurdle" by looking at the pieces only in light of the goal needs. In that way he has "transformed their functional value."

7. His attitude is one of directed, highly selective search.

8. He arrives at the solution gradually, *i.e.*, step by step, although this is not very obvious when there are so few steps and no errors.

9. His aim is to find a corner, which will supply the goal need for corners.

The following chart summarizes the small group of cases which, on the S.S. puzzles, were solved by a method similar to the one just studied. There is only a small number of them, probably because the material inclines the subjects to move the pieces as soon as possible instead of "thinking" about them. The instructions to make a plan first, were calculated to check this impulse and so get a greater variety of method.

Digitized by Google

CHART ANALYZING THE OUTSTANDING CHARACTERISTICS OF ANALYSIS

Subject	*Klo* *A*	*H.H.S.* *A*	*H.W.* *A*	*B.C.* *A*	*B.C.* *C*	*Whe* *C*
1. Time occupied	20″	70″	very short	25″	21″	55″
2. Number of moves	4	4	5	4	4	3
3. Moves made before relation to goal seen	yes	yes	yes	yes	yes	yes
4. Hindsight by recognition	none	none	none	none	none	none
5. Amount of foresight	all	all	all	all	all	all
6. Verbalized analysis of goal	remark 1 & retrace	r. 1, 4	r. in retrace	r. 2, 3 & retr.	r. 1, 2	r. 3, 4 & retrace
7. Verbalized analysis of pieces in goal terms	r. 1 & retrace	r. 1, 4	r. 3 & retrace	r. 2, 3, retrace	r. 1, 2	r. 3, 4 & retrace
8. Attention centered on pieces	in terms of the goal only					
9. Attention centered on goal needs	yes	yes	yes	yes	yes	yes
10. Apparent attitude undirected search	no	no	no	no	no	no
11. Apparent attitude directed search	yes	yes	yes	yes	yes	yes
12. Sudden solution S, gradual solution G	S—almost immediate	G	G	S—almost immediate	S—almost immediate	S—almost immediate
13. Nature of verbal report—logical and related to moves	yes	yes	yes	yes	yes	yes
14. Verbal report disjointed	no	no	no	no	no	no
15. Number of inferences	several	several	several	several	several	several
16. Verbal report of O's feeling about the solution			"planned first"	"have basis for whole solution"	"worked as planned"	"First saw it"

Digitized by Google

D. Comparison of Trial and Error and Analysis as Forms of "Thinking"

The most easily recognized distinction between this "analytic" form of thinking and the T.E. variety is that in A., O sees the reason for his moves before he makes them, instead of making them to see what will result. He makes enough observations and inferences about his goal to know what is needed to reach it, and about his material to meet those requirements. Consequently he comes to see the basic puzzle relationship (rightly or wrongly) before he moves the pieces instead of after he does so. Seeing the relationship is the crucial factor in both, but in A. it is seen before manipulation, in T.E., after.

A second quite obvious difference is that in A. observations and inferences play the role of means to the desired end, while in T.E., M. plays that role.

Probing deeper, we find at the root of these differences the fact that in A., O centers his attention on the goal, becoming aware of its specific requirements and looking at the material only in light of this knowledge, while in T.E. he centers his attention on the material and keeps the goal at the "rim" of attention—to use Titchener's phraseology. As a result, he is more fully conscious in A. of the steps that bring about the solution; his search is more highly selective, and he is apt to speak of this method as "figuring it out" as compared to what he calls "just playing around" in T.E.

It seems to me that such differences as these justify and even demand a separate term for the method, and that, if we call the method in Protocol 1, T.E., because it depends chiefly on trial moves, the term A. is appropriate here because the solution is based chiefly on logical reasons and only secondarily on trial moves whether imaginal or actual. Whether the logic was correct or not does not affect the question of whether it was used. If the logic was correct, there was a minimum number of moves while, if it were not, the moves were wrong and O had to begin again, either returning to "the figuring it out" procedure or changing to moving the pieces more at random (T.E.). "Figuring it out" can of course in a general sense be called T.S. because it is exploratory but that designation hits only the external of O's work, not the specific processes which are responsible for this final solution.

A. and T.E. have several processes in common—attention to the goal, observation of the material, recall, if the problem calls for it, M., and seeing the crucial puzzle relationship. But in T.E., O's

Digitized by Google

attention to the idea of the goal is rather remote and diffuse; in A. it is specific and concentrated; in T.E. seeing the relationship is merely a matter of recognition; in A., of foresight; in T.E., O comes to see the relationship by means of M.; in A., by means of inferences. In T.E. the moves are made before the resultant relation to the goal is clear; in A., after. Since most of these differences seem to be a function of attention, which is capable of variations as to direction and intensity, there is no claim made for mutual exclusiveness of these methods. The indications are, rather for a continuum.

E. Solutions Combining the Two Methods on the Simple Squares

Most approaches combine T.E. and A. and in that respect merit the term G.A. as it is used in this paper for the T.C. solutions. But on the S.S. the solutions are so short that even in combinations it is difficult to get the feeling of gradualness, so I have not applied the term, till the T.C. is discussed.

A detailed examination of some of these combinations on the S.S. puzzles will show the likelihood of a graded series between the two end cases of what Ruger has called animal and human learning. They will also show that in such combinations the high points of the thinking, the most effective and active moments, are those at which A., not M., occurs; that when the two are used together the T.E. plays an auxiliary, though essential role.

Protocol 3, A.W.P. on *Puzzle A*

Plan: 2 minutes, 15 seconds

1. All alike.
2. Trying to find out how to start.
3. Looks as though first thing is to —— top corner as a corner of the square (A.).
4. ——— in upper left, say ——— (M.M.) ——— E* ——.
5. Trying to find where rest were going, which side would fit along —— couldn't see it (M.M.).
6. Not ———.
7. See two possibilities —— 3rd too.
8. Harder than I thought —— not sure of plan.

Solution: 1 minute, 16 seconds

16 Moves	*Remarks*
1. Turned piece on diagonal to use as corner (M.). Test move correct.	1. Put corner as side—o.k.

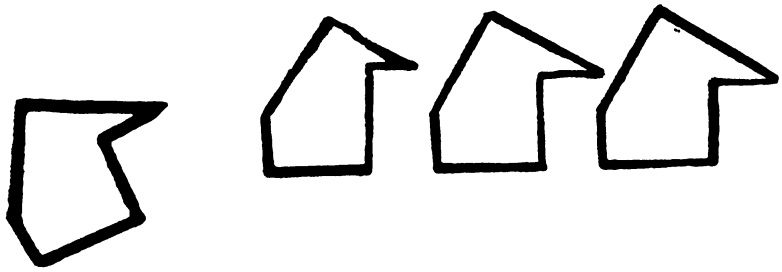
Digitized by Google

2. Moved other pieces, at bottom of board several ways trying to find correct placement for 2nd piece. Never correctly in relation to 1.
3. Changed tactics after a pause, and place 2nd corner diagonally opposite first (same corner of piece).
4. Moves other 2 pieces in quickly. (M.).

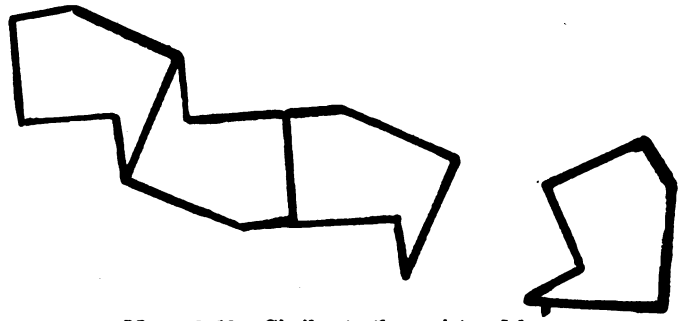
2. Next going to be a shot in the dark — — —. O Becomes intent.

3. There it is.

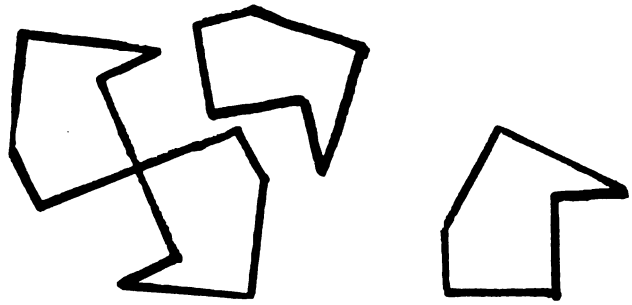
A.W.P. on Puzzle A. Protocol 3, p. 26



Move 1



Moves 2–13. Similar to those pictured here



Moves 14–15. Move 16 simply fills the last gap

Digitized by Google

Retrace:

Have a similar opposite corner. More logical than I thought it was. I had no idea of what I was doing. First put one corner in upper left hand and looked to see if I could make a second fit ——— by a mirror image. Absolutely T.E. Looked for another corner down here. Knew it ought to be symmetrical because only 4 pieces—I mean 4 all alike. As soon as I turned lower one knew it was solved. Rest just a question of turning over the pieces.

Conclusions from Protocol 3:

What are the outstanding characteristics?

1. The time and error score show this work to fall between that of the T.E. and the A. solutions, Protocols 1 and 2, which we have studied in detail.

2. His verbal report is related to his moves, but there are long pauses during the planning when he is manipulating the pieces mentally and during the solution when he is actually manipulating the pieces without seeing the reason for his moves in relation to the goal. In this he resembles Protocol 1. There is little verbal report during M. or M.M.

3. Remark 3 under plan indicates that he is observing the pieces and implies that inferences have been made from them in relation to the goal about which he has also made inferences (see retrace).

4. In the plan O sees the reason for his first move, then tries to "see where the rest would go" mentally. In his solution he puts down the first piece correctly according to plan, not at all disturbed by the diagonal "illusion," then, knowing the next piece must make a sort of "mirror" image of the first drops to M. to find it. None of the moves during this time are correct as to relation to the other piece and the goal. Then, rather abruptly after a short pause, he places the second piece correctly. Why he does it is not clear. We cannot deny that the M. gave the clue to the correct move, but it seems more plausible that O was affected by his search for a mirror image. There is no answer in the record, but it resembles an S.R. based on O's earlier observations.

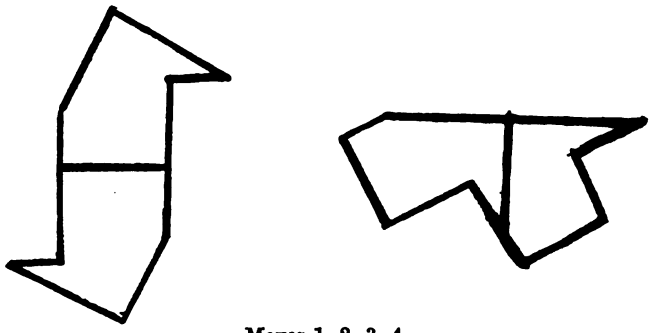
5. Obviously, this is a combination of the two and possibly three more extreme methods. Like many Os, when stuck, he drops to T.E. but the progress is made chiefly during the A. In this case M. seems only to have delayed the solution. At least we can see that the M.M. in the plan did not accomplish a great deal. Both E, and an assistant who was watching, felt that the placing of the 2nd piece was due to a vague sort of A. rather than M. O, himself, said, "Hm, more logical than I thought." He had said it would be a "shot in the dark," and his retrace goes back to say "absolutely

Digitized by Google

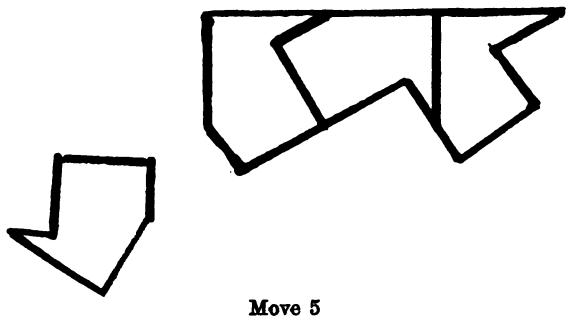
T.E." All this suggests that certain processes may go on at a low level of attention and take part in the solution without O's noticing it.

6. The same suggestion of levels occurs again when we note that at 1, under plan, O says "all alike" without verbally drawing the conclusion from that fact (that if two are placed correctly the problem is virtually solved). Yet at 4 under solution, and in the retrace, O confirms our guess that he really made that inference. The precise inference utilized in the solution may have been drawn at 3 under solution. Many Os do the same thing; others seem to do it but do not show even in the retrace that they were ever aware of it. We can

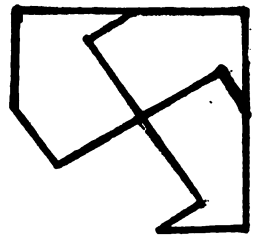
J.E.D. on Puzzle A. Protocol 4, p. 30



Moves 1, 2, 3, 4



Move 5



Move 6. Move 7. Simply fills the gap

Digitized by Google

conclude that some thoughts are so rapid, so fleeting, or merely so taken for granted that they are not verbalized and not always even noted by O.

The next case is also a combination of T.E. and A., but T.E. is used in quite a different way.

Protocol 4, J.E.D. on *Puzzle A*

Plan: 1 minute, 15 seconds

1. 4 roosters.
2. Trying to match 4 flat sides and 4 flat corners (A implied).
3. Looks like largest side matches with short angle.
4. I'm going to put 2 sets of 2 together at divergent angles (in a different way) and see if one-half forms a square.
5. If not, move a 3rd and see if space left will take 4th.

Solution: 2 minutes, 45 seconds

7 Moves	*Remarks*
2 errors	1. There are 2 possibilities; neither makes sense.
1–2. Combinations as suggested.	2. See half of side of a square, yet can't match (A.).
3. Pause.	3. ——————— pause.
4. Changes piece in worst combination to correct and recognizes its value.	4. ——————— in a different way —— o.k.
5. Adds 3rd slowly and looks at space (foresight).	5. ——— apparently successful.
6. Adds 4th deftly and quickly (foresight).	

Retrace:

Set up 2 possible obvious but different combinations to get a picture of one half or some half. Out of one I got idea of a long side. By taking section of the other that was a complete misfit and trying it on a possible different angle, I found a third combination and a good one.

Conclusions from Protocol 4:

1. The time and error score places this solution between Protocols 1 and 2 in efficiency and somewhat better than Protocol 3. Furthermore, his recognizing the first correct move shows superiority to the blindest T.E., but the lack of good transfer shows inferiority to A.

2. He differs from the blindest T.E. also in that his remarks are closely related to his moves and there are neither long verbal pauses nor series of rapid M.

3. His aim is to find 4 corners and 4 sides by M. We can see the effect of his aim on his method, and how he directs his attention.

Digitized by Google

4. Remarks 2–3 under plan show that he has analyzed his goal somewhat as to needs and is observing the material in light of the A.

5. We have a clear-cut example of restricted sector of activity. Instead of analyzing the pieces also, to concretize his goal needs, or of trying to visualize them, O plans a series of trial moves to be made before the reason for them is seen, but to be inspected for relation to the goal needs as soon as made. In this way he uses M. strictly in service of his goal.

6. This more effective but auxiliary use of T.E. stands in clear contrast to the blinder variety in protocol 3, where we found attention to the goal only in a general way during rapid M. This O attends to specific goal needs and regards each piece in light of this knowledge, even though each move is "blind." It is a pretty bit of evidence for the conclusion that when T.E. is used less blindly and in connection with A, it is more effective but plays an auxiliary role, while the A. carries the real progress.

F. Levels of Problem Solution According to O's Degree of Understanding of the Goal

There were several levels *at which Manipulation* was used in solving the problems.

1. Almost completely blind manipulation, with O vaguely aware of his goal. Protocol, 1, page 19, is at this level. So are certain cases in which O, having started by partially analyzing the situation, drops back to M, because he is "stuck." (For example, A.W.P. Protocol 3, page 26, the 12 moves under solution move 2.)

As indicated in the preliminary discussion of results, T.E. is, even in such cases, not completely "blind" or random. At least O is sufficiently aware of his goal to recognize the move which produces its requirements. He may be conceived to be working on some sort of vague hypothesis, such as, "to achieve the solution the pieces must be put together," or, a little more specificially, "the sides must fit into each other somehow."

2. Manipulation to discover the specific relation between pieces when the general puzzle relationship is understood. Puzzle B is frequently solved in this way. O sees immediately that the cross is to go into the center (see Diagram, page 11) and the notches of the pieces will fit around it somehow. Then he uses M. to discover just how they will fit. Perceiving the general relation has "restricted his sector of activity," he still, however, moves the pieces in certain ways without knowing exactly what the outcome will be hoping, by recog-

Digitized by Google

nition, to find the needed relation. Again we deal with hindsight; again we have diffuse attention to the goal; again O depends chiefly on M. but the M. is less blind, and accordingly its efficiency as a method is greater.

Similar in its degree of blindness is J.E.D.'s use of M. on Puzzle A, Protocol 4, page 30. He uses it to concretize a goal need he has discovered by analysis.

3. M. as the vehicle of a new inference—a source of information about the pieces in relation to the goal. Again some relation to the goal is seen, and it is much nearer the center of attention. O is using M. to complete an inference, which, though not successful, leads to new and important information. For example:

Protocol 5, Ha on *Puzzle B*

Plan:

1. I see at once these are different.
2. Believe this small end must fit into each corner of the cross. Can't go any other way.
   Looks at it for a long time.

Solution:

Moves	*Remarks*
Moves the pieces around cross. Looks skeptically at 1st piece. At 5th makes remark (M.).	1. Can see where I'm wrong at first guess. It's going to make the figure *too long* and all the pieces won't fit that way (A. after the moves).
Moved 6–7–8–9–. Used pieces to rotate around the cross but alternating the long and short edges.	2. *Shorten it* up o.k.—that makes it look better. Very sure I have it now.
	3. Pretty strong satisfaction when I turned the first piece around (Move 6).

Retrace:

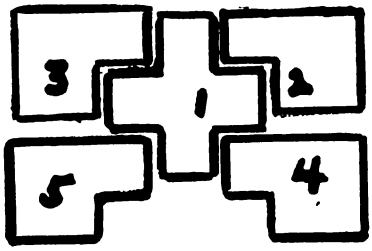
Interest at difference. Cross in the middle gave me the idea. Something to work around. Decided that would be in the middle, then looked to see if the ends would fit. When I saw they did, decided that was the solution. Vague feeling of satisfaction, reduced a lot because I was not sure now they would fit.

M. used here moves 1–5, raises the level of O's work in that he is able to make a new inference on the basis of it. Had he merely been looking at the pieces trying to "figure" it out, he would not have been able to make it. M. brought out new fact which might otherwise not have been noticed and which helped lead to the solution. M. makes a distinct contribution even though it plays an auxiliary role.

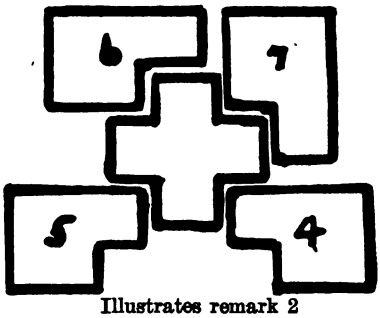
The second remark under solution causes the crucial move 6.

Digitized by Google

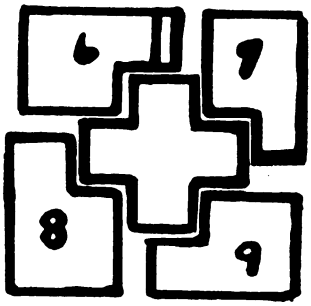
Ha on Puzzle B, Protocol 5, p. 32



Illustrates remark 1



Illustrates remark 2



Illustrates remark 3. The numbers in the diagram represent the order in which the moves were made.

Move 7 implies a further inference about carrying out the relation of size of pieces to size of final square.

Move 8 and 9 merely complete the picture, repeating the last two moves.

4. M. used to test clear-cut hypothesis. The difference is that the relation to the goal resulting from the move is seen ahead clearly and needs only verification. This is the least blind variety of M, if, indeed, it belongs in the same category as the cases we have been

Digitized by Google

discussing. But if we regard it as an end case, we avoid the need for a separate class for this one use of M. Besides, of course, the hypothesis it tests may be wrong and the O blind in that sense. If so the M. is valuable as a criterion for discarding a useless hypothesis.

A. W. P., Protocol 3, page 26, move 1, illustrates this use of M. Many others will be recognized scattered through the various protocols. Since it is a very familiar use, it hardly needs further illustration.

This survey of the levels of M. emphasizes *certain* important uses, which are worth stopping to list, at the risk of digressing a moment. They are:

1. To keep O working at his task.
2. To produce a combination which O can recognize.
3. To discover facts about his material which might not otherwise be learned and which later become useful in solving.
4. To raise the level of work.
5. To discard useless hypothesis and moves.

G. Levels of Analysis Based on Degrees of Clearness as to Relation between Pieces and the Goal

Although we have up to this point considered T.E. as "blind" in a general way, and A. as understanding, we must note that there are degrees of clearness in O's understanding of the goal, as there are degrees in his blindness about it. As a matter of fact, having drawn up a series of levels for T.E., we might consider ourselves as merely continuing that series when we do the same for analysis.

In the T.E. solutions, O's attention was directed chiefly to the pieces but he did not observe, before moving them, their relations to his goal. Now we find that in analysis O's attention is directed chiefly to the goal, but that his analysis of it is not always complete or clear. He may:

1. Look for one side, or for one corner.
2. Look for four sides, or for four right angles to use as corners.
3. Look for one side and one corner.
4. For four corners and four sides.
5. He may add to this an estimate of lengths and areas in a general, or a very exact way. (Need to cover space.)
6. He may then concretize these needs by inference or leave that to M.

Digitized by Google

What we have, in short, is a continuous series of degrees of clearness, on O's part as to his goal, in relation to the problem situation, with a difference between T.E. and A. from vague awareness to complete and specific understanding. It depends on the direction of attention. Again and again we are reminded of the importance of attention as the "integrating" factor in making a temporal pattern of thinking. As we find an increase in attention to and understanding of the goal, we find also an increase in the number of inferences and a decrease in the number of moves. But just as there is always some response to the goal, so there are always some moves necessary to solution.

H. Solutions of the Simple Squares by Sudden Reorganization

We still have to examine some of the relatively few cases among the S.S. of solutions by S.R. In these, O sees the crucial puzzle relationship with apparent suddenness—as if directly, the previous work seeming to have nothing to do with the reorganization. Here the term "insight," as originally described by Köhler and Yerkes in connection with their animal work, would seem to offer a contribution of some technical value. But because of the later more generalized use of the term to include cases of recentering that are not sudden, perhaps S.R. is a better term especially since it also serves to contrast it to G.A.

We find these S.R.s occurring on several levels of complexity. In some of the simplest cases, however, so little is reported that we can scarcely afford to draw conclusions from them. They appear very like the immediate solutions.

The two following cases are good examples.

Protocol 6, P.F. on *Puzzle A* (see diagram, p. 11)

Plan: 2 minutes 40 seconds

1. I'd take the second piece and fit it into groove of 1st. 3rd upside down will correspond to bottom edge — — — 4th — — —.
2. Think the end would be sticking out — — — no (sharply).
3. Place 1st on table and put small side of it into groove and other side as side of square. 3–4 would fit in. (Talks faster and more certainly).

Solution: Four correct Moves.

Retrace:

At first glance the idea was to get points into grooves. They messed up the square surface. When I imagined placing the 3rd I found the end sticking out.

Digitized by Google

Looked at pieces again and suddenly saw the square edges as points instead, and thought of putting them all in the middle, then the diagonal would form a large part of the side.

Conclusions from Protocol 6:

1. Although this includes A. at remark 2, remark 3 and the retrace show that the solution came not through O's attempt to use her inference by getting rid of the points, as Ha does in Protocol 5, but by a sudden change in the functional value of the parts, *i.e.*, the former corners now become "the points" to be got rid of.

2. She speaks much faster and with more assurance as soon as she sees this.

3. The background is not clear, but we can guess that O's inference at remark 2, plays a part by releasing her attention from the real points, leaving her free to concentrate on another part.

Although the case gives too little report to contribute much to our study, I include it because it represents the simplest cases of S.R.; is clearly different from the M.M. and A.; brings out the importance of seeing relations, so stressing the essential similarity of all forms of arriving at the solution.

On a slightly more complex level are those cases which occur because of a physically changed perspective.

Protocol 7, Ha on *Puzzle D*

Plan:	*Remarks*
1. In imagination moves little triangle to top edges of center cross. (M.M.)	1. These are different.
2. Cocks his head to the left and looks at the cross from the side.	2. Compare two edges to see if they fit.
Solution:	3. If they do, what will fit in the hollow?
1. Puts a triangle into a notch correctly.	4. Don't believe that is the way it is.
2. Puts in the others very quickly, leaving it in diamond shape.	5. I see it now — — the triangle goes in here.

Retrace:

When I moved over here and looked at it differently, I saw in a flash how it was made. The certainty very great. Knew first attempt was wrong as soon as I compared the possibilities. Before that I knew that if I knew one, I knew all. It was the perspective that did it. The previous attempt had nothing to do with it whatever — — nor the reasoning.

Digitized by Google

Conclusions from Protocol 7, Puzzle D:

1. The retrace explains the background.

2. "Saw in a flash" reveals again a fundamental characteristic of S.R.

3. Although this is on a very simple level it teaches us something of value for understanding the more complex ones. For it did not happen miraculously. Nor did a new process, different in kind, bring it about. There is always some stimulus and response that leads up to the change. In this case it was a physical shift of perspective which made him see the center piece D_5, no longer as a cross but as an incompleted square (see diagram, p. 11).

4. O considers that the previous reasoning, remark 3, had nothing to do with the solution. We have no factual basis for disagreeing with him, but it is possible that this also formed part of the background leading to move 2, if only by making him turn his head to look for other possibilities. If so, the background is a little more complex than we surmised at first.

When the problem itself is complex the change of attention may be due to the gradual building up of a background of knowledge about the pieces, which enables O to interpret accidental cues in a new way. Such cases will be discussed in Part III.

M.G.'s solution of Puzzle E reveals a slightly more complex background. This one actually occurs in connection with the recognition of the solution and is therefore hindsight as far as the puzzle goes. But it carries the principle of the construction to the other puzzles showing definite foresight in that respect. O solves puzzle E by a combination of A. and T.E. which gives us no added information for the point we wish to make, so that it is necessary to quote only her retrace.

Protocol 8, M.G. on *Puzzle E*

Retrace:

All the time I knew I had the wrong method because the pieces for the outside really fit other ways. I vaguely saw the relations. At one time I suspected a part was left out. I'm pleased now. When I turned over the next to the last piece I saw a new relation that I had been feeling for all along. I was trying to use the pieces in the wrong direction as right angles rather than diagonals. I did the same with the first piece, then by accident turned one the right way and the 2 fit another way. This developed the feeling that these pieces shifted in the diagonal rather than the horizontal direction. It didn't seem sudden, but it was a seeing into a problem. The principle involved became clear suddenly, however, after being vague for a long time. This at the last two pieces.

Digitized by Google

Conclusions from Protocol 8, Puzzle E:

1. The background is clear consisting of

(a) The fact that E1–2 fit 2 ways aroused the feeling that something was wrong.

(b) The "feeling for a different relation all along" referred to O's groping for a relation between this puzzle and one done long before. The "feeling" was probably the vestige of a memory of a past experience.

(c) The cue was the unexpected use of a piece on the diagonal and served to bring the relation "felt for" to a conscious level.

2. Immediately the whole puzzle is seen in a new light and this carried over to her other solutions.

3. This subject, who was much more sophisticated than the others, was able to observe and report on her processes more closely. Had she been unable to report on the "gradually developing feeling" the result would have seemed like mere recognition. Yet it was more than that, for no other O was able, when he did get 4–5 correct, to verbalize what had caused the difficulty—that it must be used contrary to expectation, on the diagonal Consequently we can presume to give her background, past and immediate, definite credit.

Before leaving the subject, it will be interesting to show by example the difference in development and feeling between an S.R. and A., each on almost equally simple material. Below we contrast Protocol 9, a vivid S.R. and Ha solving Puzzle B (see p. 32) by analysis.

Protocol 9, R.W. on *Puzzle D**

* O had been given this puzzle as an almost completed square, and this time as an almost completed cross. (I had been working out times and forms of presentation of material. The method is a function partly of her experience but serves none the less well as an example of S.R.)

Plan:

(M.M.)	*Remarks*
1. Tentative push and back to place, in imagination.	1. If these pushed in—not a square (M.M.) and (A.).
2. Moves her fingers the way the lines would be.	2. Or, if I put in corners as yesterday, I'd have a figure with slanted lines—no good (A. under wrong direction).
3. Looks at the pieces intently.	3. Must straighten the lines (A.).
4. Just looks and touches various places.	4. This may be the same cross. It can't because sides are cut off sharp, also uneven (A. under wrong direction).
	5. Neither plan works. I'm stumped.

Digitized by Google

6. Is very quiet, looks intently without moving.
7. (E. suggests doing it) in imagination.
8. At E's suggestion, tries as planned—hesitates—almost jumps out of her seat (M.M.).

6. Now I'm looking at the pieces and trying to see some shape into them.
7. If I were to move I'd do what I did yesterday, but it wouldn't work (A. under wrong direction).
8. Now all lines are slanting so it ——— Ooh — — (with great excitement) (S.R.).

Solution:

4 correct moves. Then moves square off the diagonal.

Retrace:

Something happened definitely. Just as E suggested, I pushed them together mentally and saw a new aspect. I had started 4 rather than 2 lines and opposite ones were parallel. Meanwhile thought what was needed to turn that figure into a square. Realized effect of relative position to me ———. This is a concept not a picture ———. It was not so definite as I have verbalized it. It was a movement of myself to a new position. (She didn't move physically.)

Conclusions from Protocol 9, Puzzle D:

1. Again the picture to E and O is unique and typical of the usual description of sudden insight.

2. Again we can find the background for the S.R. It consists in:

(a) the knowledge from past experience, that the little triangles would fit into the notches;

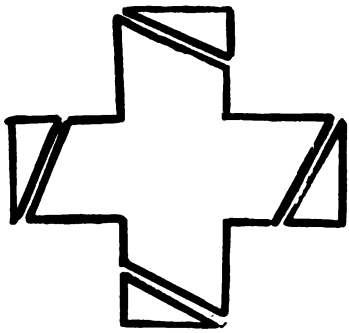
(b) the visual image of how these would look if she put them in;

(c) the vague knowledge of what the square should look like.

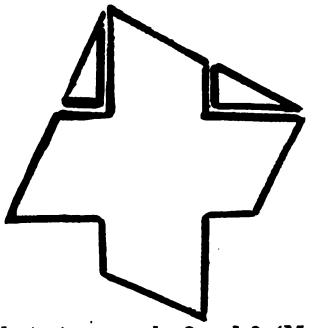
3. Ha on B (Protocol No. 5, p. 32) comes to see a new relation between the piece in light of the goal, in quite a different way. He placed the pieces around the little cross, incorrectly; noticed that his trial move was not right and said, "wrong at first guess. It's going to make the figure too long and all the pieces won't fit" (an inference in relation to the goal). "Shorten it up," and he concretizes this idea by moving a piece around after a conscious relation to the goal is clear to him. "O.k., that looks better" is his comment. In Protocol 9, by contrast, the steps leading to the S.R. were not clear to O as she went along because her direction was wrong, but they clicked together in relation to the goal after E's suggestion. In this case, the steps were concealed; in that of Ha they were revealed most clearly. One gets the feeling of synthetic *versus* analytic solution. At the point of the cue, R.W., although unconscious of the reason,

Digitized by Google

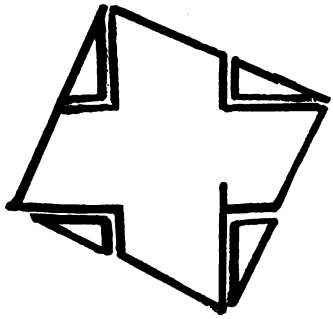
Protocol 9. R.W. on Puzzle D



As presented. Illustrates remark 1



Illustrates remarks 2 and 3 (M.M.)



Illustrates remark 8 (M.M.)

sees a new aspect. When Ha sees a new aspect, he knows the reason. He has made an inference about the relationship and concretized it.

These cases also contrast the typical attitudes very well. R.W. is more passive in her search; the situation seems to carry her, while Ha is active, dominating the situation. We might say the fluctuations of attention are directed more by the environment in S.R. and

Digitized by Google

by O's purpose in analysis. Hence S.R. seems to come from outside the O.

But we must clear up one further point. Ha does exactly what some of Duncker's Os do, and he calls it insight. First comes penetration of the difficulty, then filling the "gap." How is it possible to reconcile these interpretations? It is merely a matter of terms. Duncker and Wertheimer would call each step in the G.A. an insight, and of course each observation, recall, or inference in relation to the goal does bring increased understanding of the whole. But a subjective reorganization of the whole field is not noticeable in the one case, while it takes place very obviously in the other. Why use one term to cover two such different types of solution? If we stick to the term insight for S.R. or, better still, discard the term altogether and use simply S.R. we can distinguish clearly between the two ways of solving. In neither case is a new kind of process involved. Thus we can contrast S.R. with A., leaving T.E. as the name for the more blind approach. Surely this is better than to lump them all as insight, or as analysis, or for that matter as T.E.

Direction and Restricted Sectors

It seems worthwhile to digress for a moment, for Protocol 9 can carry us one step further. It shows what kept O from seeing things in relation to the goal and what made a change possible. O was inhibited because her direction was wrong. She was seeing the diagonals as such and assumed they must be used so. E's suggestion that she try the plan she considered impossible forced her to change her direction. She then noticed 4 lines and asked herself, "What is needed to turn that figure into a square?" That was the cue which caused her previous ideas to click into relation with the goal. The importance of direction is brought out here, and the facts fit in well with Maier's stress theory. E's suggestion presumably provided the necessary extra stress for breaking down the inhibition set up by O's false direction.

Furthermore, if we accept Woodworth's idea that all work on a problem is confined to a sector determined by the subject's partial understanding of the problem, we can then interpret direction as O's initial understanding, thus clarifying the concept somewhat. If that first direction is correct the rest of the solution consists in a series of subordinate "insights" (plus M.), each becoming more specific. The ensuing M. takes place in a more and more restricted sector of activity, and is thus more effective and correct moves will be

Digitized by Google

more easily recognized. If the first direction is not the objectively "correct" one, solution must occur through a change of direction and the whole situation is much more difficult. For within the limits of a wrong direction, M. is of little avail except in connection with a critical attitude on the part of O in relation to his idea of the goal. Nor are correct moves apt to be recognized. The wrong direction may be changed by G.A. or S.R. (see Chapter III).

I. The Effect of the Nature of the Problem and the Nature of the Subject on the Method Used in Solving

The S.S. puzzle solutions show vividly the effect of the construction of the puzzle on the method O uses, and contrariwise, the even greater effect of the nature of O, through his temperament, and his past and immediate experience.

The little cross of B, for example, seemed to be a prepotent stimulus. The complementary shapes of its arms to the notches in the pieces that go with it led the large majority of Os to the immediate conclusion that it was to go in the center, with the four equal pieces around it. Whether O was led into difficulty by the obviousness of this depended, apparently, on his temperament. The more impulsive Os jumped to the conclusion that they had solved the problem, only to find, that there were several ways in which the pieces would fit. Then, baffled, they resorted to a series of moves to find the correct fit. Others realized the possibilities but decided to leave the specific relation to M. Still another group made inferences about the pieces, in terms, say of the length of the required size, until they saw the specific relation and then based their moves on their analysis. Some, though naturally inclined to jump to conclusions, took the more cautious attitude because they had had disastrous results with a previous puzzle.

The prepotent stimulus of Puzzle C seemed to be the long side of each piece. This frequently led O to make an inference in terms of goal needs, because it suggested the side of a square, even to Os who did not usually analyze the goal needs. But again O's nature was apt to change the picture. One subject who spoke of the long sides as sides of the square, while she was making her plan, nevertheless reverted to her old habit of simply matching edges, as soon as she actually began to move the pieces. She noticed that the two long sides would fit together, couldn't resist using them so, and made two small crosses as a result. This led her, not to another inference

Digitized by Google

in terms of goal needs, but back to the T.E. method she had been using all along. Another O who had just reasoned out the previous problem very nicely on the basis of making corners, failed even to mention the long sides, but took the longer route and painstakingly worked out a way of constructing corners, again.

This sort of thing runs through all the puzzles. The part played by the construction of the puzzle can be seen in the following chart, which shows the number of times each puzzle is solved by T.E., A., and so on.

Puzzle	*A*	*A+T.E.*	*T.E.+A*	*T.E.*	*S.R.*	*Not to be Counted because:*		
						Solution Immed.	*Not Given*	*Solved by Recall**
A	5	5	2	3	2			3
C	6	6	4	1	0	4		
D	0	3	0	0	5	13		
E	1	10	6	2	0			2

* Presented twice.

Conclusions:

1. Puzzles A and C are analyzed most often.

2. Puzzle B is omitted from the chart because the general plan is usually seen immediately and then filled in by M. in a restricted sector, so it doesn't fall into the above categories, in any strict sense.

3. D. is grasped immediately, or solved by S.R. in a large majority of cases.

4. E. must really be considered two parts. The first three pieces offering long sides generally lead to analysis, but the last two must be put in on the diagonal, and the space left for them is deceptively large (see illustration one, Protocol 21, page 74) and usually throw O off on a tangent of M. Fourteen of twenty-one did this, and most of these broke up what they had already accomplished, giving the impression of confusion and blindness throughout. If we considered only the first part, puzzle E would fall into the A category, whereas the last part falls much more definitely into the T.E. class than the chart shows.

Column 2 could logically be merged with column 1; and column 3 with 4. If we did this, the differences between the puzzles in their

Digitized by Google

effect on the method used for solution would stand out even more clearly:

	A.	T.E.	S.R.
Puzzle A	10	5	2
" C	12	4	1
" D	3	0	5
" E	11	8	0

J. Summary of Results of Chapter I*

What stands out clearly from the data so far?

1. That within the exploratory but "insightful" course of a complete thought movement, there are three relatively distinct methods of approach to the solutions:

(a) One is comparatively blind up to the point of solution and may be called T.E. because recognition of the essential puzzle relationship depends on moving the pieces about before the reason for any move becomes clear.

(b) A second is comparatively understanding and may be called A. or reasoning because seeing the crucial relationship depends primarily on observations and inferences in relation to the goal rather than on the moves. The latter are made only after a reason for them becomes clear.

(c) A third falls between these two as to blindness and may be called S.R. because the solution appears at the point at which the interrelation of the pieces to each other seems suddenly to change and become clear. The whole picture becomes a different one for O.

2. Solution by T.E. is usually less efficient than by A. resulting in longer time and larger error scores, and less transfer.

3. The conscious content (mental activity) seems to be slight while M. is going on.

4. Many Os consider M. what thinking is not, and if the correct move were not recognized eventually, it would be just that, for the problem would never be solved.

5. But the T.E. approach consists of more than mere M. It is affected by O's perception of the goal, and seeing the basic relationship is essential. M. is merely its chief tool.

6. That the term Trial-and-accidental-success may well be used as descriptive of the exploratory character of the whole thought move-

* For Abbreviations see p. 1.

Digitized by Google

ment, while that of T.E. may be applied to the blind solving process described in Protocol 1, p. 19. (These terms could easily be reversed —or the word "blind" prefixed to the one which is to refer to the more limited use of the term.)

7. M. in a T.E. solution may occur on several levels, acting always as a test move, but differing in degree of "blindness" as to relation to the goal.

8. Although inefficient or secondary as a thinking process, M. has definite and essential values:

1. To discard useless hypotheses;
2. To raise the level of work;
3. To increase O's knowledge of the material.

9. Most cases combine T.E. and A. (except in very simple problems where we sometimes find these in isolation) and when they are combined the A. carries the progress and O's orientation to the goal, while the M. falls into an auxiliary, though still essential, role. It would be more accurate in such combinations to speak of A. plus M. for the A. carries the subject's orientation to the goal.

10. M. is the most obvious response of O in T.E. Inferences play that part in A.

11. In combinations, M. is more effective than when used alone in T.E. but the effectiveness seems to be a function of the process used in connection with it.

12. S.R. seems to be a unique "flash" process both to E and O.

13. It is not really sudden but usually depends on some previous response which leads up to it; nor does it involve any new kind of process.

14. S.R., except in immediate solutions, invloves a change of direction, and either brings the solution with it, or leads to a narrowed sector of response.

15. O's aim and the consequent direction of his attention are important factors in determining the method used in solving.

16. All three methods are based on observation, manipulation and seeing relations in light of the goal, and are held together in a complete thought movement by more or less attention to the goal.

17. The nature of the puzzle, and of the subject also, plays a role in determining the method used by O.

18. The following characteristics of the thought processes make them difficult to observe:

1. *Timing.* We are not dealing with the space and time rules

Digitized by Google

of explicit behavior. Many thoughts are fleeting in nature and the physical limits to speed are lacking. Many O's report the feeling that several thoughts were "simultaneous."

2. *Short-circuiting.* Once a thing has been thought through and become thoroughly familiar it is taken for granted, and skipped over, although it remains perfectly available for use. Naturally this makes following an O's processes very much more difficult.

3. *Levels of consciousness.* Some ideas are so fully conscious that O can verbalize them accurately. Others he does not verbalize although he may recall later and know that he "must have thought" thus and so, although he was not conscious of it at the time. Others are never verbalized, but O's moves show that he must have been aware of a certain fact or relationship or he could not have done what he did.

Digitized by Google

CHAPTER III

SOLUTIONS OF THE TOTAL CROSS PUZZLE

(A comparison of Sudden Reorganization with Gradual Analysis on more complex material)

A. Aims

1. To study the rôle of experience by comparing the solutions of those who were given experience with the squares before they had to make the large cross, and those who were given all the pieces at their first sitting and told to make a cross. For such a general comparison it seemed unnecessary to equate the groups.

2. To provide conditions which according to the gestaltists' view would give sudden insight every chance to take place. For it was a problem in which an "intimate and obvious" relation existed between the pieces, and one which was known to be well within O's grasp. Here was a chance for O to discover the relationship among the pieces. Would he do it by sudden insight?

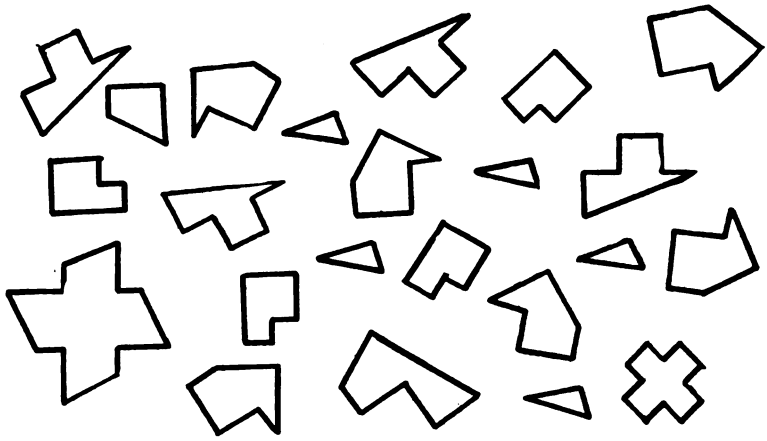
3. If so, we could study the nature of this process, and its relation to the other forms of thinking. In this project one problem interested me particularly. Several investigators have, more or less incidentally, commented on the occurrence of foreshadowings of future solutions. I wanted to put the spotlight on this phenomenon.

Mention Made in Literature of This Special Problem

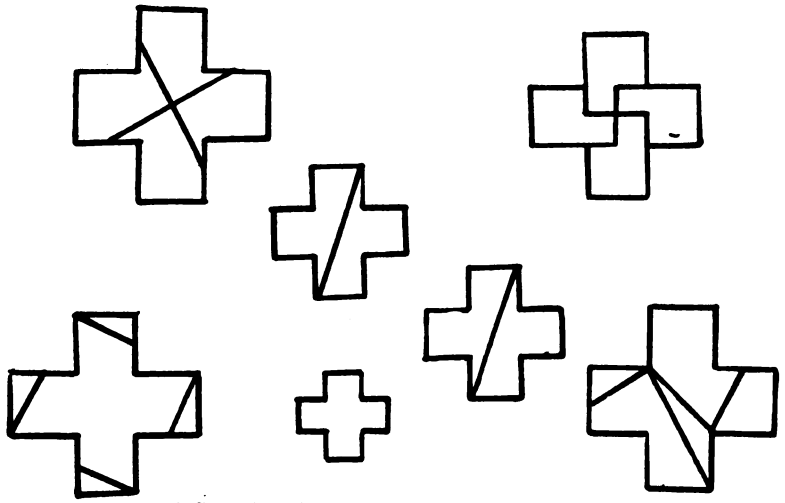
Poincaré, Wallas, Rossman, and Patrick speak of the incubation of ideas; Heidbreder contrasts participant behavior with spectator behavior and holds that variations sometimes occur as a result of the latter, through the "accretion of sublimal stimuli." The subliminal stimuli consist of observations made while the attention is general. Alpert calls the result of exploration and elimination "insight" which she says may also be considered as a subjective reorganization and may be sudden or gradual. In the gradual variety, she says, O sometimes shows awareness of the means he is going to use to solve a problem, without apparently knowing until later just how he is going to use them. Ruger speaks of analysis as a method of solving problems and defines it as a seeing-through or "insight," which, he says, is a distinct experience and may be very sudden. However, he also finds cases of "locus analysis" or of O vaguely catching the essential movement, or discriminating between major and minor elements which are a step toward solution. That they are sometimes

Digitized by Google

not explicit, he says, accounts for the fact that the actual adoption of the variation may be gradual, as reflected in such remarks as "I think I'll get it next time."



Mixed Presentation of T.C.



The Total Cross Puzzle presented as a series of small crosses

B. Preliminary Survey of the Present Results in Relation to This Part of the Literature

What are these "foreshadowings" of the final reorganizations? Taken as a whole the statements cited concern two quite different sets of facts without making clear the distinction between them. I believe the present study sheds some light on the situation in the following ways:

Digitized by Google

First, the data on the T.C. show two ways of reaching a solution. One by G.A., a step-like analytic process combining A. with some M., and the other by S.R. Ruger applies the term "analysis" to both; Duncker, the term "insight." Yet they seem distinct experiences, both to O and to E, so that it would be more useful to separate them by name as well.

Secondly, the data enable us to distinguish between the out-and-out steps in A. and the concealed steps which are foreshadowings of later S.R., while the above statements confuse them so that we are at a loss to know whether the writers are speaking of one process or two, and whether either is gradual or sudden.

Actually, the "foreshadowings," mentioned in the literature, refer on the whole not to the steps of a G.A. but to the concealed steps leading to S.R. It is in these foreshadowings that I was especially interested. The data show that what has hitherto been noticed occasionally as such a *foreshadowing is really always present as part of a developmental course leading up to each S.R.* The S.R., then, does not come out of the ether, as it seems to do, but is led up to by one or more observations, recalls or inferences, for the most part concealed from both E and O. They remain unnoticed because they are not consciously related to the goal at the time they occur, but are out of focus, so to speak, and only "click" into relation at the "moment of illumination"; or else they may be concealed because they come too rapidly to be noticed.

C. Detailed Analysis of Cases of Sudden Reorganization

Among the Os who had experience with the squares first, most solved by S.R. It is to those cases that I would like to give special attention in the following section, for it is there that the phenomenon of "foreshadowing" occurs. Later, these S.R. solutions will be compared to those by G.A.

To make quite clear just what I mean by S.R., to show its unique nature, and to study its developmental course, I shall quote and examine minutely the examples of it.

Protocol 10, B.C.* on T.C.

Mixed Presentation (see diagram p. 48)

Moves	*Remarks*
1. Looks over whole board. Eyes move rapidly. Fingers many pieces, particularly D_8 (observation).	1. Seems to be all the pieces I've used before — — — — I wonder if all really here. (Recall, not in relation to present goal.)

* O does not stop to ma' a plan. E did not interfere when this happened on the T.C.

Digitized by Google

2. Picks up D_5.	2. Logical to start with big cross (D_5) (implied A).
3. Fingers B_5.	3. Maybe the little cross will complicate the thing. (A).
4. Places D_5 at bottom center so it looks like a cross and would not make a square.	4. No ready solution but will start with this (D_5).
5. Piles them up in assorted order.	5. Get all similar pieces together so if one works all will.
6. Looks around at all pieces and fingers the little cross.	6. Maybe with little cross as center — — — This has to be much broader than these arms at center. (A).
7. Fingers B_5.	7. Maybe this little cross ought to be started out as a square, because so many pieces need a big center. (A).
8. Picks up B_5—stops, hesitates, and is very quiet a moment — — — —.	8. (Raised his voice and said excitedly) This is a good one, the real solution finally hits me. Make five squares and this can be the center.
9. Makes the five squares with only one error and puts them together to form the Greek cross.	

Retrace:

I was thrilled when it finally dawned on me, but should have thought of that first because I had been making squares. While working I had noticed there were 5 squares but didn't tie it up to the present problem. I recognized parts to go with the various squares. The clue came from the sq. to be used in center —because to use up all the pieces would have to get a large center. At that the idea came that I had the material for the square and the fact previously noted that with the little cross I had thought of using in the center none would fit in except the 4 used before as a square. Then it suddenly dawned on me that it would be one arm and I had the material for other arms. I remembered pieces very well to sort them. I had already sorted them at the beginning though with different plan in mind—merely that if one could be used probably the others of its kind could.

Conclusions from Protocol 10:

1. Obviously we have here a solution pattern which tallies up very closely with the usual description of sudden insight. We find a sudden drop in errors, the change in expression and tempo, the verbalization "it hits me," "it dawns on me."

2. What has gone into making of this S.R.? It does not "Spring full-armored from the mind of Zeus" but is the culminating point in a developmental course. Nor does any new and different process occur. Certain observations, recalls, and inferences spread out dur-

Digitized by Google

ing the whole solution "clicked" together, as it were, to give a new meaning both to the piece (functional value if one prefers the term) and to the whole. Tracing the facts so accumulated we find in the background:

(a) The general shape needed (shown by choosing D_5 to start with);

(b) The inference as to size needed ("this has to be much broader");

(c) That B_5 could not be used alone;

(d) That only certain pieces could be used with it;

(e) That the old pieces were present;

(f) Then the rapid almost simultaneous recalls that these pieces made a square before, that he could use a square now, and that 5 squares were available and could be used. These last facts had actually been noted earlier, he says, but not tied up to the present problem.

Certainly there is nothing miraculous about this sort of experience. It is, to quote Razran—"mechanical and summative in structure" and perhaps also "emergent and supra-summative in function." The suddenness, one finds, refers not to the lack of background, which is always present in some form, but to the fact that it is concealed until, at a certain cue, the new relation suddenly clears, the chaos is gone and the road ahead is open.

The background is similar to, but not exactly the same as, Heidbreder's spectator behavior because the stimuli and the reactions to them are not so much subliminal as out of focus in relation to the present goal. Like hers, the observations, etc., were made when the attention was general. Certainly the background is related to Alpert's "awareness" in gradual insight, to Ruger's "vaguely catching the essential movement" and to Rossman's "incubation." But heretofore only such parts of the background as directly involved some part of the actual solution were noticed, because the investigators were not chiefly interested in this phenomenon. Hence "gradual insight" seemed a rare thing. Closer analysis reveals that it is the usual thing whenever the problem is complex enough to be beyond the subject's immediate apprehension span.

3. The S.R. can be seen to depend not only on its immediate background but on previous experience as well. If O hadn't had experience with B_5, this little cross would not have instantly suggested making a square of it along with B1, 2–3–4. If O had not made 5 squares before he could not have jumped from the idea of

Digitized by Google

1 to 5 squares so easily, nor would he have known how to make them. Consequently the confusion could not have cleared so suddenly, the errors could not have dropped out, and the whole solving picture would have lacked suddenness and excitement.

4. That foresight rather than hindsight is involved in S.R. is self-evident.

5. It seems as if the rapid coming into relation with the goal of several previously noted facts makes such an impact that O doesn't realize what brought it about and feels as though it really came from outside himself. Not "oh, I see the relation," but "it hits me."

6. Because of this rush one cannot see just what is the mechanism of the "click together." We might hazard the guess that it is in the nature of an inference something like "oh, if this, and this, and this, is so, then . . . there it is," but short-circuited. At any rate it seems logical to postulate an inference, until we find the facts.

7. At this point it seems worthwhile to digress for a moment to compare our findings to those of Patrick's in *Creative Thought in Poets*. For it is only in the solutions by S.R. that we find anything really similar to the four stages of thought she discusses.

In the T.E. solutions we have a period of active work which may be comparable to "preparation" but consists in manipulation rather than in getting impressions. Then we have recognition which is indeed a moment of "illumination" but after the fact, and providing its own verification. Incubation seems to be missing entirely, unless we can apply it to correct moves not recognized, and these appear to be more a matter of chance than of incubation. At least there are no obvious grounds for adopting the more complex interpretation.

In A. we have a period of very active work which we might call preparation. During this period we sometimes have a recurrence of the idea to be used eventually, but there is nothing involuntary about it. The moment of illumination is missing, because O becomes "illuminated" very gradually, and verification takes place at each step. Since attention is strictly on the goal needs, there is little chance for involuntary or subconscious work.

In S.R., however, our first period is often very like that described as preparation. There is much active work and many impressions may be gathered, some of which are only indefinitely related to the goal. Any one of these may recure frequently till finally in a "moment of inspiration" it becomes specifically related to the goal and the problem is solved. Thus incubation has been occurring during the preparation period. Then follows a real period of verification when the "formulation" is tried out by manipulation.

Digitized by Google

We find no separate period for this incubation. The ideas simply recur during preparation. Nor can the incubation take place during rest periods, or periods of thinking about something else, for O stays with his task till he has completed it. We did find in B.C's work, and in most others, a short pause preceding each "illumination" which at first seemed as though it might actually be an "incubation period." Subjected to closer scrutiny, however, it turned out to be very much a part of "illumination" instead, for it is in this period that these "dormant" ideas click into relation with the present goal. In those cases in which there was practically no period of preparation (like that of Do.) all the necessary recalls and inferences seem to have been made during this period. We might of course say that incubation and illumination come together here, but again, there are no adequate grounds for adding the concept of incubation. It would be in excess, in this connection.

Our present conclusion must be that in simple puzzle construction we do occasionally find a process similar to incubation occurring as part of the preparation period and forming a part of the developmental background of S.R.

Unfortunately not all cases are so clear cut as Protocol 10. The patterns vary, and in order to understand the variable nature of the S.R, one must examine carefully all of the available cases. The one following differs somewhat from the preceding one.

Protocol 11, H.H.S. on T.C.

Mixed Presentation

Moves	*Remarks*
1. Looks over all. Fingers and moves slightly a number of pieces in an indecisive way (Obs.).	1. I'll never do this. A sweet one! Oh Gosh, I don't know where to begin.
2. Puts E_1 in center and looks around at others.	2. This (E_1) is a good place to start because it has to be a big cross (A.).
3. Puts E_2 next to E_1 — —.	3. Oh gee, that's easy! Because I realized I
4. — — — — touches B_5 and almost simultaneously remarks (3 under remarks).	was making original square I made before, and if I made 5 squares they'd all fit to make a cross—if I made five — — if all here (S.R.).
Works out separate ones with little trouble.	

Retrace:

The one with the little cross gave me the idea. I was doing top one, took one glance at the cross. Another thing gave me the idea — — — —. I was

Digitized by Google

trying to think what size it would be—then it dawned on me that a cross equals 5 pieces. Not sure how—as I put 2nd piece on, I saw all the pieces as before—that gave me the idea that the whole thing was the same. Maybe the little cross had something to do with it. There was not so much figuring out as guessing. Realized that 4 squares were available and would do it, didn't know that 5 were available till afterwards.

Conclusions from Protocol 11:

1. At first glance it is hard to tell just what happened here. We are struck only by the very definite change which took place between "I'll never do this—" and, "Oh gee, that's easy." Such an abrupt change is sufficient to place the solution in the S.R. class and further study backs this up.

2. The preparatory period gives no sign of what caused the change. We might conclude that this "insight" did indeed come miraculously, but the retrace tells what really happened. Certain observations and recalls combined to bring about the S.R. but instead of being spread out through the preparatory period, as they were in Protocol 10, they seem to have occurred in a short pause following it in such rapid succession that O did not verbalize them at the time. We get the impression that they are so crowded, fleeting and incomplete that O is trying to grasp them. Hence her quiet intentness. Then in the retrace she seems to be giving each one more time and completes it. Even the retrace is confused in this case. Definitely, however, we learn that the change did not occur spontaneously. Definite stimuli and responses led up to it.

3. The moment of illumination was typical enough, although the "secondary characteristics" in the O were far from exaggerated. Knowing the O well, I am inclined to consider her quite restrained nature responsible.

4. The fact that O considers the solution reached before she stops to explain how she reached it is typical of S.R. as compared to G.A.

5. It is clearly a case of foresight.

6. The remark just preceding the period of verification shows the tendency to jump to conclusions—very frequent with S.R. She is convinced she has solved yet admits she doesn't know if she has all 5 necessary squares.

7. The pause in this case is very casual and comparatively relaxed. It consists mainly in a searching glance around the board.

Protocol 12, Ei on T.C., is vivid at the moment of illumination, but like Protocol 11, almost lacking in indications of background.

Digitized by Google

Protocol 12, Ei on T.C.

Presented as Crosses

Plan, only:

1. — — — all of them — — — — — let's see — — — they have — — — that's a job — — — —! (Obs.).
2. Just wondering whether I should leave them in shape of crosses or take apart (Vague Hyp.).
3. — — — — — don't see any relation at present.
4. Can't get far if put 2 crosses together, because pieces sticking out, which may or may not be what I want — — the vertical, horizontal proportions will always be wrong (M.M.).
5. — — — — seems wrong — — — — at present not thinking anything — — —.
6. — — — — if I took it apart a hopeless mess — — — — I wouldn't know what to do — — —.
7. — — — much better manipulate them — — — no plan at all — — —.
8. Let's consider other matter — — — might turn upper one around — — — —.
9. — — — — oh, oh, suddenly got an idea — — — I could make squares — — if made 4 before (S.R.).

Retrace:

Recognized pieces in 2 lower left and right hand crosses E and A. At first glance, it was a confused mass. Then thought of keeping figures as they were. Didn't get far with that — — no headway. Always uneven—horizontally and vertically. Then couldn't see what — stumped for a while and was just roaming around the field taking bearings — — no actual thought. Had recognized them before but didn't associate present problem. E.—"Why later connected?" O.—"Well crosses were no help and I needed help badly. Units necessary, or an awful mess. Suddenly recalled square units again and decided to try. I would call it an insight. Can't recall what did it. As long as I had cross set could make no headway — — — discarded it and looked for something. This may have led to square but I am uncertain."

Conclusions from Protocol 12:

1. O's words and manner quite definitely indicate an abrupt readjustment.

2. This O is not inclined to note and report fully his own processes, so we have little explanation of what occurred. The previous experience and its applicability are recalled between remarks 8 and 9. Yet at least a negative background is suggested. Discarding the wrong direction (putting crosses together), when it appears unworkable, opened the way for the facts noticed before (that the pieces were the same, etc., see retrace) to be used. We might hazard the guess that at step 8, O noticed that the pieces now aggregated in this cross were the same collection previously used for a square. So his demand for units was met. That need for units of

Digitized by Google

course was itself part of the background knowledge which led to S.R.

3. The inapplicability, for him, of the first recognition of the material shows the futility of even recalled experience unless O sees a new relation to his goal.

4. It is of course foresight. The usual pauses must have been filled with noticing that his experience applied and drawing the conclusion from it.

5. The tendency to jump to conclusions is demonstrated again for O doesn't know if he made 4 squares, nor that 5 are now needed.

6. The pause before 9 differs from that in Protocol 11 in that during it O becomes markedly more quiet and intent.

Protocol 13, Do on T.C.

Mixed Presentation

Plan, only:

1. — — — — a cross — — — — well — — — — that's fine (sarcastically) (Obs.).
2. — — — — long pause — — — — you know I think — — — — —.
3. — — — — Oh, I think I could do it. — — — — did I have 4 squares? (S.R.).

Retrace:

Recognized pieces immediately—big cross first then the little one. Looked at the large cross and thought the only way I can use it is to make a square of it, and if I make a square of that, then must have all squares. So then — — — had a feeling I could get 5 squares and that 5 squares could form a cross somehow. Then happened to glance at cross and was sure it was o.k.

Conclusions from Protocol 13:

1. A sudden volte-face follows a brief, blank period of confusion.

2. Typically, the background is given in the retrace. It consists of:

(a) Recognition of the pieces, first the big cross, then the little one;

(b) Recall that the big one will make a square;

(c) Inference that this is the only way he can use it;

(d) Feeling that he could get 5 squares (although speaks of 4) and that 5 would make a cross somehow. Since O calls this a feeling rather than an idea we can assume that it lacked clearness.

3. Again we have foresight, and O states that he has reached the solution before he explains how he reached it.

4. Verification occurs by his "glance at the cross" but it is not apparent whether this took place before or after the moment of

Digitized by Google

illumination at remark 3; and by the M. which followed, in the solution.

5. The pause, which occurs before the S.R., is accentuated because so little is said altogether. It is also very suggestive of the possibility that what occurs during the pause is the thoughts which are later expressed in the retrace. O's silent and intent attentiveness is most likely an attempt to grasp the several inferences, recalls, and observations that came so rapidly, and which, to judge by O's speaking of "feeling" (above under conclusion 2) are not always clear or complete, but are very fleeting. If this deduction be correct, then it is no wonder O is very quiet and intent; it is no wonder the impact of so many ideas at once is strong enough to make him forget the cue; to make him unable to say what is going on till after he has grasped the meaning of it; to make him jump to conclusions; it is no wonder that the experience is flash-like; that O is usually very certain of his result. As in Protocol 12, p. 55, the pause before 3 is very intent.

The following case is somewhat similar.

Protocol 14, M.M.E. on T.C.

Mixed Presentation

Plan, only:

1. Oh, well, this is a little dif — — — — Oh, I see all the same pieces (Recog.).
2. Quite simple. Only a question of assembling them (S.R.).
3. I don't have to put them together, do I? It wouldn't be worthwhile.

Retrace:

I recognized the large cross. Then I checked the corners. Then, that the second one (B_2) made individual squares.

Conclusions from Protocol 14:

1. This case is just one step removed from immediate solution. There is, however, a definite complete change. O breaks off a word in the middle and pauses—a very short time, and then the whole situation is different. There is little excitement, probably because the confusion was of short duration.

2. During the pause, which may be explained much like that in Protocols 11, 12, and 13, O was keyed up. He had started work with a certain amount of tension, as if he were prepared to keep on working for a while. This held during the very brief pause. At its end his attitude became one of relaxation, of having finished.

3. Some of the background is given in the retrace, but probably most of it is skipped over even there.

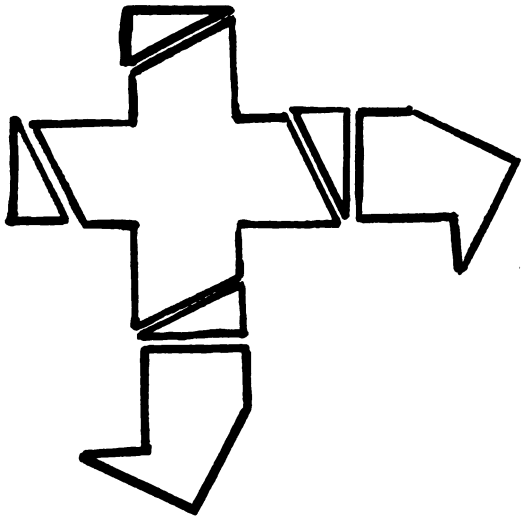
Digitized by Google

4. O jumps to the conclusion that he has solved, with great certainty.

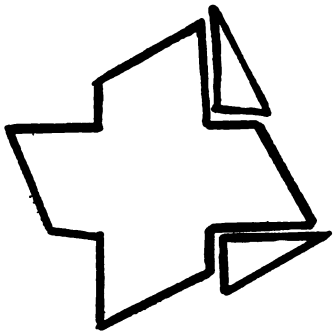
5. The clear-headedness of this solution suggests the essential similarity between S.R. and A. And of course the same processes are at work—observations recalls, and inferences.—The difference is one of timing—they seem to come more simultaneously in S.R.s of this type. In other words, the same processes occur but in a different time order. Consequently our attention is again drawn to the fact that there is probably a gradual series rather than two mutually exclusive types of thinking.

Klo's solution by S.R. resembles that of B.C. in the way the back-

Klo. Protocol 15



Illustrates 6 M.M.



Illustrates 10

Digitized by Google

ground develops. It is a gradual accretion of knowledge rather than a series of rapid deductions or recalls.

Protocol 15, Klo on T.C.

Presented as Crosses

Plan, only:

1. — — — — The first thing that occurs to me may be based on nothing — — use D_5 as center (Obs.). (See diagram).
2. — — — or could crosses be pushed together to form a large cross? — — — don't think so — — — —.
3. Trying to figure areas to see what size and if I can use crosses together as they are — — — — (A.).

* D_5 designates the center cross of puzzle D (see diagram, p. 11).

4. — — — — no, can't because B* is skewed — — can still work it out

* O pointed to the cross made out of puzzle B.

if I want to — — — — — — — (whispers) in terms of units of small squares — — — — —.

5. No, it wont work that way. I'd have 30 units and need 25, can't visualize, B gives about 6½ instead of 5.
6. Another thought—have 4 pieces exactly alike (pieces of puzzle A). I could shift them around center cross — — — imagine one around D_5. I don't know which to pick.
7. — — — — n.g. — — — — — — — ? I was looking to see if anything to make a square with and guess I can with these 4 Cs. (M.M.).
   E.—"How use it?"
   O.—"Use it as center piece—had already, in computing units, recognized crosses as equal to large cross on basis of area."
8. o.k. but don't know whether I could pattern out the rest.
9. Don't know if I can use large cross—D_5. (It seems too large. It seemed larger, he later said, with triangles around it.)
10. In thinking of removing little pieces, I saw that they fit into the space the other way so that I see now that I can make a square out of this one, and now that squares are mentioned think 5 will make squares, only B gives me trouble. The area is about same. I'll consider it solved (See diagram) (S.R.).

Retrace:

Looked at C and it reminded me of what I had done before.—Looked at D with idea of what to do with big center, then suddenly realized it could make a square. Didn't recognize pieces till I saw C with idea of breaking them up. Not sure — — — — even yet, about B. Subconsciously the fact that you said to make a plan helped me because I knew one could break them up and get a plan.

E. "What caused success?"

O. "Final success at 2nd square. First had no meaning but 2nd indicated a trend. Got it step by step till 2nd square, then an inspiration. Plan o.k., just a matter of moving the pieces. When rejected cross units because of the 25 unit system, the whole thing seemed haphazard for a while. I started looking again for a starting point, and found C. When 2nd square came up, I hooked up idea of units, because I knew squares would be about equal to num-

Digitized by Google

ber of units in crosses, and had figured that out already. Also your question as to how I was going to use the first sq. seemed to tie up. Didn't see it right away but somehow the influence of the word square helped, when the second square appeared, to make me know it was a good plan—in some vague way. Now only the doubt about this one (B) is left. But think width of arm narrower than that of the small cross and if so, o.k. I don't think it will stand in my way.

Conclusions from Protocol 15:

1. There is little excitement at this turning point which occurs when O finds a second square is possible, but from there on he takes his solution for granted even though he is not sure that Puzzle B will work out. His orientation is suddenly stabilized, as it were.

2. This background is interesting because it develops gradually and shows what a variety of observations, recalls and inferences can be collected and click suddenly into relation with the present goal at a particular point while the O is working in a different direction. It consists of:

(a) Knowing he needed units because he was told to make a plan and because without them it would be an impossible mess.

(b) When he discarded crosses as units, noticed C would make a square.

(c) E's remark at this point, "How are you going to use the square?" emphasized the idea of squares—and though not used then, helped form his later decision.

(d) O knew the areas would be approximately satisfactory if he used the parts as squares, because he had figured them as crosses.

(e) The cue occurred as O took a triangle off D imaginally because it seemed too large—he then saw the cross as a square (D_5), recalled experience, and was fortified by the above information sufficiently to jump to conclusion he had solved.

Like the O in Protocol 10, p. 49, Klo accumulates a number of essential facts while he is looking at the material in quite a different way. But, unlike him, he is clearer all the way through as to the meaning of his observations for his goal. His work is nearer the level of analysis, and not so different from some of the solutions of T.C. made by O's without experience. It does differ from them in that, because of his experience, he can be certain of having reached the end.

3. His remark, "I'll consider it solved" indicates a complete change of picture, a jump to conclusion, and great certainty—all typical of S.R.

Digitized by Google

4. His lack of excitement is explained by the clearness of his processes up to the "moment of illumination."

5. The importance of the square making experience is obvious, yet so is the fact that it could not function alone, since O would have finished his solution at 7, when he recalls it. Seeing a new relation between experience and the goal is essential.

6. This solution illustrates the exploratory nature of thinking in remarks 1, 2 and 6 in which he is considering other hypotheses. Does this contribute to the final S.R.? Perhaps not directly, but it does make him try to find new ways of regarding his material—wherefore he is eventually led to the idea of using his square making experience.

Some cases are more difficult to classify. The following two hardly seem, at first glance, to fall into the S.R. group at all. Yet when we read the subjects' own interpretations of their solutions we cannot fail to see them as such.

Protocol 16, J.E.D. on T.C.
Mixed Presentation

***Plan*, only:**

1. Looking at this collection, obviously 2 parts could be central, the 2 crosses. E. "Why?" O. — — pause — — because they are regular and particularly the little one would be hard to fit in outside (A.).
2. Gee, it's a bear — — — — (Pause).
3. If I took 4 or 5 previous puzzles. Could probably put 4 or 5 squares together, superimposing them or beside each other (Verification + S.R.).
4. I think it's worth trying—got 4. Really need 5.
5. Therefore we'll make 4 original ones.
6. I know it's correct because I had 5 and small cross is Maltese and has 5.
7. Fix easiest one first, not going to remember but do them again, each as an entity using original premise of side and corners.

Retrace:

Saw no way of building on 1 or other of the central sections. As I was trying to use small cross for center (or large one) noticed that it was made of 5 squares and previous puzzles were 5 squares. Not quite certain yet. It seemed too simple—and after the last debacle, looked for something less obvious. When the 2 crosses could neither be used nor discarded, it came to me intuitively that I could reconstruct 5 squares and simultaneously the idea come that a Maltese cross is 5 squares. Came so fast that they seemed simultaneous.

Conclusions from Protocol 16 will be discussed with those from Protocol 17, which is very similar.

Digitized by Google

Protocol 17, E.V.O. on T.C.

Plan, only:

1. Looks like a combination of all the pieces (Obs. Recognition) — — It is — — this is terrific — — —.
2. — — — — (studies the board intently). How many puzzles did I do? — — — — (Pause).
3. Looked long and hard at the sample—5 — — — —
4. — — — — they were all squares — — — —
5. Put three together and — — — — — —
6. — — — — one in middle and 4 around.

Verification + S.R.

Retrace:

When I realized that they made 5 squares, knew I had it, then checked and felt pleased. It seemed spontaneous, came like a flash but I wanted to be sure. It seemed almost subconscious—to come without any reasoning, a different reaction entirely from the others. It came quickly, and I felt sure. There was no reasoning—it came right away—not confused by the pieces at all, felt at home with them. I think impulsively rather than reason it all out.

Conclusions from Protocols 16 and 17:

1. Turning point in both these solutions is not obvious, yet the originally chaotic state of the puzzle for O is shown by their comments, "this is terrific" and "this is a bear," which are followed after prolonged pauses by the right direction. Certainly the picture, in neither case, is one of stumbling more or less blindly toward the goal, nor yet an analysis of the goal followed by an active search by means of inferences in relation to it. O's own descriptions, as given in the retraces, finally place the cases in the S.R. group. These descriptions fit in extraordinarily well with the usual description of sudden "insights" in the literature in spite of the fact that neither O understood the exact nature of the experiment and was not familiar with the terms of Gestalt psychology, so that their verbalizations were quite spontaneous.

2. Background—similar in type to H.H.S. protocol 11, p. 53 J.E.D. is able to give us the steps that led to his S.R.

(1) The block because the 2 crosses competed for center placement.

(2) The analysis of the construction of B_5.

(3) Recall that 5 squares possible.

(4) The idea that cross equals 5 squares.

These all came in rapid succession, but O was wary because of previous difficulties so that instead of jumping to conclusion he verified first.

E.V.O. who was, throughout, rather quiet, neither observing herself very fully nor reporting in detail, cannot give us any idea of

Digitized by Google

what had led her to the solution, declares in fact that there was no previous reasoning. We can only infer what happened from the reports on similar cases.

3. Both cases illustrate the pause preceding illumination and proceeded with verifying before they felt that they had solved. This was because both had met with rather disastrous results before.

4. It is important to notice the differences between these solutions and some of the more clear-cut cases of S.R.:

(1) The fore period in each case is very short because O comes on the cue to his short-cut very early in the game. Consequently we get less impression of confusion and of a startling change.

(2) At the same time the usually brief moment of "illumination" is combined with the last period of verification, contrary to the usually impulsive attitude connected with this type of solution. The feeling of suddenness is consequently decreased for the O's and we have less contrast effect.

5. The same caution results in curtailing the expression of excitement at having solved the puzzle, so that the secondary characteristics of S.R. were practically lacking and it is they that lend such strong flavor to the experience. They externalize the picture.

A Transitional Case

The following case is very difficult to classify, and suggests again the likelihood of a continuous series between S.R. and G.A. It illustrates also two levels on which O may understand the puzzle situation. The first level consists in understanding what can be done; the second, how it can be done. The idea of using squares develops gradually, while how they can be used together comes quickly. Let us examine it more minutely.

Protocol 18, Whe on T.C.

Presented as Small Crosses

Plan:

1. — — — — a large cross? — — — — — — but how? (Obs.).
2. First idea is to take a large cross for center, but
3. That would leave too many corners, so must separate them (A.).
4. One at least, B_5, is solid and must be used as it is now — — — —.
5. — — — — think there is more than one possible solution — — — —.
6. — — — —? Wondering — — — — this is going to be a devil of a job if you separate them — — — — now I have an idea — — — —.
7. This one — — — — no all but 2 form squares—no every one but little one (Recall).
8. — — — —? Wondering if 4 pieces can make a cross or a square — — guess I better start M. with idea of using crosses as they are.

Digitized by Google

Solution:

Moves	*Remarks*
1. Moves 2 crosses together.	1. Ah, it looks promising—the edges at top and bottom are parallel—also sides—but — — — — (A.).
	2. Perhaps smaller crosses better to use — —.
	3. Large ones leave too many blank spaces (A.).
2. Takes 1 A to use with large crosses at center adding little triangles.	4. Have to separate some, but that doesn't hurt pattern of square — — — yes it does too (implies A.).
	5.— — — ? — — — just trying to put this back as it was.
3. Adds long triangle.	6. Would give me a long side, without anything — — — — doesn't fit — — — — this combination n.g. (A.).
4. Removes these and moves the whole cross.	7. The North, South, East, West proportions wrong and if you move the whole cross, it's wrong the other way (A.).
5. Removes 1 cross and tries B with it at "random."	8. Now try something else—just one cross (D) at center, and build around it. E. "Are you using any guide?" O. "No, except trying to keep it symmetrical, extending each arm as I go" (A.).
	9. No, because nothing will fit—not enough A's to do it.
	10. I think this is the wrong way to start, get too many corners if I work with cross (A.).
	11. Will use squares instead, I'll get farther. Could get 3 arms of cross that way. I'll do that and see what happens (A.).
6. Builds D–4 moves.	12. Now I have a center. Trouble is, not all the same size (was thinking of B without center cross B_5).
7. Makes E–8 moves.	13. Now remember false moves before with E_4 (See Retrace).
8. Adds it to first square.	14. Well, I got 1 corner—try for another. E. "Do you know if you can get it this way?" O. "No, skeptical" (refers to whole, meaning B won't make a good sq. same size so can't see final cross emerging).
9. A–5 moves.	15. Now got the 2 arms, make a third, and I'm still skeptical.
10. Makes a rectangle of B 1, 2, 3, 4.	16. This is very well but too short. (She won't accept it this way).
	17. Still, maybe I can make it go — — — —.
11. Makes C–5 moves.	18. — — — very quiet — — — (pause). Oh, now I've got it. I've got the whole thing

Digitized by Google

now—had a rectangle rather than a square. Think I can put the little cross in center. (S.R.) E. "Do you recognize it?" O. "No, I don't recall that one."

Retrace:

I recognized pieces as soon as I sat down, but not all of them. Squares, when I first thought of them because moving crosses seemed no good, meant nothing to me, except different units to work with — — — didn't see relation to the present problem. If I had seen five it might have clicked then when I came back to them; realized that square I had thought of before would eliminate extra corner. Although I knew I had three arms around my center, didn't see the relation to the whole clearly because I didn't remember B and thought whole wouldn't work if one arm was short—thought B 1, 2, 3, 4, might make a sort of square. After the rest done, realized B the only flaw and saw that needed a longer side for bottom rectangle B—mentally pulled the pieces apart to accomplish this, saw blank space left and then realized little cross might fit in—didn't know exactly how but knew it must—sure of the whole thing then—it all fell into line.

Conclusions from Protocol 18:

1. O's understanding of "what" to do comes step by step in Analysis 1–10.

2. His understanding of "how" to do it comes at once in step 18.

3. The difference between the two kinds of process is illustrated clearly and seems contingent on the availability of all the necessary knowledge factors and on their timing. But suggests the question: Why do some Os jump to the conclusion that they have solved, while others are delayed? Two causal factors suggest themselves: (1) O's tendency to be cautious or impulsive; (2) O's ability to educe relations from relatively little given material. Possibly both enter in, but on different levels.

4. Like Protocols 10 and 15, Protocol 18 shows a gradual development of the background during a long preparatory period, but the steps are much clearer in relation to the goal. Their *exact* relation, however, is not seen till step 18.

5. As part of the background, the repeated idea that squares may be used, could be interpreted as "incubation."

6. In respect to the pause preceding step 18, O's intentness during it, his reporting success before he explains how it came about, his certainty and his jump to the conclusion he has finished, are all typical of S.R. But S.R. occurs here not in reaching a general plan but in filling in a detail.

7. Taken as one complete thought movement, this protocol shows an unmistakably exploratory character and the T.S. by which he

Digitized by Google

examines other hypotheses (steps 2 and 8) and discards them, must be admitted to have some part in bringing about the solution. It does at least lead him to look for a third hypothesis, which turns out to be that of using squares.

D. Variations in the Sudden Reorganization Pattern

In collecting evidence from the T.C. puzzles for the existence of S.R. and a description of its nature, it has become apparent that not all of them follow a single inflexible pattern. There seem to be several types, varying in detail but essentially alike:

1. We have one group of cases in which the background is built up slowly and almost unconsciously during a long confused foreperiod, finally clicking into relation with the goal at a particular point. The background steps vary in the degree of clearness with which O sees their relation to his goal. Usually they are but vaguely, if at all related, to the goal but we can imagine a point at which the relation is so clear that the pattern of S.R. merges with that of A.

2. In another group of cases, we have a very short foreperiod, then a pause, followed by a S.R. that seems to come miraculously. Yet the retrace reveals that a rapid, almost simultaneous, series of deductions must have been made just before the "moment of illumination." Sometimes they are vague and half formed; sometimes they are too fleeting to be noticed at all; sometimes, however, they are so logical and clear in relation to the goal that, were they given one by one before O stated he had the solution, we should call them A. They vary in clearness but crowd together so that they create a picture that is really distinct from G.A. The distinction seems to be one of timing.

3. Very like these is a group in which, because of extra caution, the moment of illumination is combined with verification.

4. In a fourth group O gets the solution in two steps, seeing the "what" and the "how" at different times. One of these steps may come by A. and one by S.R. They bring out the differences between S.R. and G.A. and yet show the similarities in process between the two. Again, the differences seem to be in level of clearness and of timing.

Summary

What we have, then, is a distinctive pattern of problem solving descriptively designated as S.R. with varying details, but always involving a dynamic readjustment of the field which seems sudden because the reactions that led up to it are concealed. Either they

Digitized by Google

are not, when they occur, clear in relation to the goal or they occur too swiftly and fleetingly to be verbalized. At a certain point the errors drop out and the solution has virtually been reached. The essential pattern is stable but its form varies considerably.

E. Detailed Characteristics of the "Moment of Illumination"

The most noticeable characteristics which accompany the sudden reorganization are as follows:

1. A short pause of peculiarly quiet intentness which sometimes involved an appearance of great tension, and at others seemed to be merely a cessaton of all visible activity. The tension seemed to be one of suspense rather than of effort.

2. This pause ending either in an explosively expressed elation, or in relieved relaxation.

3. The sense of having the S.R. come from outside O rather than as the result of his previous work, whether A. or M.

4. There was a tendency to jump to the conclusion, with considerable certainty, that the solution had been arrived at, even when O was not at all sure of the details.

We are familiar with the outward expression of these feelings, as the often described "secondary characteristics" of sudden insight. They include, sudden changes in facial expression, bodily attitude and gestures, and speeding of the tempo.

Two Os, who described their S.R. experience particularly well, offer an illuminating starting point for the study of these subjective processes ccompanying S.R.

H.W., Protocol 19, on the T.C., after having solved each square once, was presented with the T.C. in the form of small crosses, and instructed to construct one large cross. Never recognizing the pieces, he solved it as an entirely new problem. During the course of his solution he made many observations about the parts of Puzzle A which seem to form a background for the final transformation.

At one point late in the solution, he comes down to working with just 4 pieces. He has made several T.E. moves and seems to be utterly stumped. At this point he breaks off entirely, pauses, and looks long and intently at the pieces, sitting very quietly, in marked contrast to his immediately previous behavior. Suddenly he straightens up, his eyes brighten and he begins to talk very fast as he moves the 4 pieces together absolutely correctly and with great deftness, saying "Oh, I saw it before I moved it. It came suddenly upon me as from the outside and I felt absolutely sure. Just like a flash and

Digitized by Google

I knew I was right. Wasn't conscious of it, *i.e.*, didn't reason about it—it came to me from the outside." And, later in the retrace, "When things just came together, there was a sudden glow of feeling. No immediately preceding reasoning at that point. A fusion of 2 things. Felt it twice, very perceptibly when concentrating heavily at that point.

Conclusions from Protocol 19 on Total Cross:

1. This is one of the most dramatic S.R.s.

2. Nothing could sound more spontaneous, yet inspection reveals that there is plenty of material in the background to go into the makings of the S.R. In the protocol there are about 14 remarks about puzzle A interspersed through the whole solution, including:

(a) That squares were to be made;
(b) That these 4 pieces made one part together;
(c) That the projections in it must become self-contained;
(d) That the pieces are identical so if 2 fit all will;
(e) That he needs a right angle and a long side.

Yet the way he moved the pieces showed that all these facts had not registered sufficiently in relation to his goal.

3. The characteristic pause occurs in particularly vivid form, O becoming very intent. There is nothing to prove that he did not merely see a new relation suddenly, but it seems more plausible that the knowledge he gained previously, should have clicked together at that point, making it possible to see a new relation between parts of his material and his goal.

4. O's description speaks for itself. The S.R.:

(a) Seemed to come to him from the outside without immediately preceding reasoning;
(b) It came "suddenly upon him";
(c) He "felt absolutely sure";
(d) He "saw it before he moved it";
(e) There was a "glow of feeling" a "fusion of 2 things" when O was "concentrating heavily."

R.W., Protocol 9 on Puzzle D (for complete protocol see p. 38). After working for some time on D, O had repeated among other things that if she did anything she would put the little triangles into the corners, finally said, "neither plan works, I'm stumped." Then she paused, very quiet and intent, saying "now I'm looking at the pieces and trying to see some shape into them." After a moment, "if I were to move I'd move the little pieces as I said, but it wouldn't

Digitized by Google

work. E then suggested her trying it. O paused again, trying it implicitly, and said, "Now all lines are slanting so it ..... pause ..... Ooh ..... great excitement." She almost jumped out of her seat. "Something happened definitely. Just as E suggested, I pushed them together mentally and saw a new aspect. I had started 4 rather than 2 lines and saw that opposite ones were parallel. Meanwhile thought "what is needed to turn that figure into a square" and recalled the effect of its relative position to me. This is a concept not a picture ..... It was not so definite as I have verbalized it. It was a movement of myself to a new position. (She did not move physically at all.)

Conclusions from Protocol 9:

1. The background of this is discussed on p. 39.

2. The pause ends in an explosive excitement rather characteristic of this volatile subject.

3. Her full explanation in the retrace of what happened suggests again that the quick recurrence and fusion of the background factors form the content of the pause. The question then arises, "If O is seeing relations, making inferences, and recalls, why is the result so explosive; why does it have that flashlike quality; come with such certainty; seem to come from without?" The answer is implied in her remark "This is a concept not a picture ....." The ideas that come are probably not complete nor clear, but half formed and vague and fleeting, and they come very rapidly. O's quietness and intentness would be an attempt to grasp everything, and the vagueness would make it seem to come from without, while the crowding of many impressions at once would make a strong impact leading to O's certainty, to his forgetting sometimes what brought it about and to the flash quality of the experience. Yet in the retrace the "picture" often becomes clarified into a "concept." Her expression "it was a movement of myself" is an interesting description of what the experience of S.R. feels like to the subject and fits in well with the thesis that the ideas which come are not clearly or fully thought through at the time, although the subject may complete them in the retrace.

These various conclusions are borne out by some of the other cases. Taking the characteristics in the order in which they are listed at the beginning of this discussion, we find:

1. In these pauses one senses a quality of emotion; in some, almost of will, as if O's need to solve was so great that, failing to figure it

Digitized by Google

out, the solution must be made to come to him, as it were. Perhaps we see here the psychological background for the expression "necessity is the mother of invention." H.W. speaks of it as "concentrating heavily at one point"; R.W., as trying to see some shape into the pieces. Another O said, "Crosses were no help and I needed help badly. Units necessary or an awful mess. Suddenly, then, square units were recalled." E.V.O. had done very badly on the earlier puzzles, she was disgusted with herself, and afraid she would take very long on this "terrific" one. She had to go home soon, too, and faced the puzzle with what seemed to E at the time, grim determination. E's notation on the protocol reads that O's manner was peculiarly quiet and intent—one of great concentration compared to her former self-consciousness.—Tense at first, she gradually relaxed and smiled at the end. The "willing" is not the result of personal effort, but of need; the tension that of suspense, not of work. Furthermore not all pauses have this tone. In some cases, like that of Do and H.H.S., it is the quiet merely of the cessation of visible activity. O seems only to be trying to grasp something that is not quite clear, or is very fleeting.

2. Explosive elation or relaxation and relief. B.C., page 49, illustrates the pause ending in an explosive way. He raised his voice and said excitedly, "This is a good one! The real solution finally hits me." M.M.E. showed definite relaxation; E.V.O., relief. The feeling tone at the point of the S.R. is one of elation and thrill as compared with the quiet satisfaction connected usually with G.A. It seems to indicate a greater emotional involvement in S.R.

3. The sense of having the solution come from outside oneself is also rather common. The expressions, "It dawns on me" and "It hits me," "It came suddenly upon me, as from outside," are illustrative. So are "Wasn't conscious of it—didn't reason about it—it came to me from the outside," and "It came like a flash—it seemed spontaneous. It came quickly and I felt sure. There was no reasoning; it came right away. I think impulsively rather than reason it all out." This feeling would be quite understandable in terms of the unclearness and half-formed and fleeting quality of some of the inferences.

4. Another concomitant of S.R. is the tendency to jump to conclusions and consider the puzzle solved without being sure of the details, yet being very certain of success. One subject after a short pause which consisted merely in looking around the board at the pieces in a general way, said suddenly, "Oh, gee, that's easy.

Digitized by Google

Because I realized I was making the original square I made before (puzzle A) and if I made 5 squares they'd all fit to make a cross—if I made five, if all here."

Another subject doesn't seem to jump to a conclusion but is very certain: "Only a question of assembling them now. I don't have to put them together, do I? It wouldn't be worth while."

A third said, "I felt absolutely sure—just like a flash and I knew I was right."

This attitude toward the S.R. is understandable too in terms of the crowding of many impressions in a short space of time—sometimes apparently simultaneous.

What stands out from this discussion is the fact that though certain characteristics are apt to occur with the S.R. solutions, we can not rely too much on them. Always, S.R. seems to be preceded by some sort of pause, but the other factors vary in degree according to the nature and previous experience of the subjects, and the immediate situation.

Any of these characteristics may appear in connection with other quite different experiences, such as the tenseness ending in thrill at recalling a name that was proving resistant to recall. There, too, we are trying to grasp unclear bits of half-formed ideas. This lends support to the thesis that O is trying to grasp fleeting, half-formed ideas during the pause; and suggests that the feeling of familiarity may play an important rôle in the distinct emotional tone accompanying S.R. and absent in the more analytic solutions.

F. Preliminary Survey of Results on Gradual Analysis

In our attempt to classify G.A. solutions by separating them from S.R., we find many cases falling between the two groups. In some G.A. the subject's retrospective report indicated a very gradual development, though his remarks and behavior during the process seemed to show one or more sudden turning points. In others, O did not, at the turning point, see his way clear to the solution. He may have reached the turning point by a series of inferences, well aware all along that he was making progress, and therefore with no sense of sudden discovery at the turning point. Still others experienced no particular turning point at all. We may therefore postulate a continuous series running from S.R. to G.A. The difference between the end cases in this series is that the steps leading up to

Digitized by Google

the S.R. are hidden whereas those leading through G.A. are clearly revealed.

The most obvious characteristic of G.A. is a zigzag quality (described by Claparède) with so many trial moves as to suggest the term T.E. But this appearance is superficial; the trial moves are auxiliary rather than primary and serve mainly to discard hypotheses, rather than to form them; they do not carry the real progress of the solution.

What does then? The implications of the goal and of the material are seen in relation to each other. The essential process is seeing relations, making inferences based on observation and recall, all within the framework of the problem. We might speak of "inferential behavior." The zigzag procedure, carefully examined, reveals a series of steps, spiral perhaps but leading nearer and nearer to the solution. Each step is a clear advance toward the goal. Confusion gives way to clear vision gradually rather that at any single point.

These forward steps are "insightful" in the sense that each adds to the understanding of the problem. But this is insight in the "result sense" and the term makes no technical contribution to our study, while it tends to obscure the distinction between the gradual process and the sudden reorganization. The gradual process is analytic, the S.R. more synthetic. So we propose to adopt Ruger's term, A., for the gradual process. The further distinction made by Duncker between "mechanical" and "organic" analysis also applies very well to our data. Sometimes the A. starts with the goal and works backward; sometimes from the given material, and works toward the goal, and sometimes it works in both directions to meet in the middle.

We find our best examples of G.A. in the solution of the T.C., especially when this problem was set without affording preliminary experience with the small squares. Zigzag progress with "organic analysis" was common, but there were only a few cases in which O went through the whole puzzle in the blind, stumbling manner we called T.E. often found with the simpler puzzles. Nor, conversely, did we find any solutions by A. alone. Instead of pure T.E. or A., we find, more typically with the big puzzle, a mixture of blind M., A. of the given material, and forward reference to the goal. Some of the cases classed as G.A. contained many blind moves, few inferences, and very little foresight, falling very nearly into the T.E. class. Always, however, what A. there was, carried the process. Therefore G.A. seemed the better classification.

Digitized by Google

G. Three Cases of Gradual Analysis

Our next step must be to compare in detail some of the actual solutions by G.A. to the S.R.s we have been examining. Protocol 20 provides a satisfactory example.

Protocol 20, C.K. on the T.C.

*Moves**	*Remarks*
1. * O didn't stop to plan.	
	1. I notice 2 ($C_{1,2}$) alike and 4A also (Obs). So while this may be large, there is some similarity in the way it is made (A.).
2. Piles the similar ones together.	2. Proceeding on theory that each side is like the other, all equals, and sees what's left—try to make a center out of that (A.).
3. Looks at 4 piles.	3. That's an extra reproduction. It's composed of 5 squares (A.).
4. Looks at left-overs, then at sample.	
	4. I'm debating 2 theories—that of 5 squares, and 4, with miscellaneous inside.
5. Fits them in (M.).	5. Obvious the little triangles fill out the D_s.
6. Moves E 1, 2, 4, 3 in various positions (M.).	6. Trying to make a square of the remains which doesn't seem successful.
7. Adds triangle.	7. Oh (merely because last piece fits).
8. Puts 2 pieces in various positions.	8. Goes to C and measures sides to see which side is the right length.
	9. Getting into all sorts of difficulties—can't get beyond 2 sq. Too lazy to figure out size of the whole.
9. Adds long side to side of made square, then adds the 2nd correctly and finishes it.	
	10. I was working to make square of same size when 2nd piece fit knew the same sequence would work. How 2nd fit in is more than I can tell. It was the acute angle making a right angle.

10. O goes on with too little verbalization to give clear idea of his processes. He seems to continue to fall back on T.E. for making the specific square.

Retrace:

Not sure if center would be regular, therefore sorted out regular ones and tried that. When they fitted ———— (probably meant irregular ones) E 4, 5 fooled me. The main thing is not to let them throw you. Got to start on system based on preliminary surveys as to what the problem consists of. Got the idea of 5 squares from the sample and proceeded fairly clearly from this and the fact that there were similar pieces. Assumed there must be some relation between them.

Digitized by Google

Conclusions from Protocol 20:

1. O analyzes his goal very early and concentrates his attention on finding what is needed. He observes his pieces strictly in relation to these goal needs. Probably as a result of this his direction is correct from the start and this enhances the contrast to S.R.

2. The rôle of T.E. Because of his correction, his T.E. activity sector is restricted from the beginning, and the M. is, as we would expect, quite effective. O is not delayed much by leaving the concretization of the goal needs to M.

3. His solution is gradual, and there is no startling turning point or "moment of illumination."

4. We can trace his progress in a series of observations and inferences 1–5. Then he falls back on M. "too lazy to figure out size of whole." In this way, after remark 9, he gets the second square and assumes, without surprise, on the basis of his earlier conclusions, that he has the right plan.

5. His retrace shows how he feels about his own solution and contrasts with those of E.V.O. and J.E.D. done by S.R.

6. What we have here, then, is a gradually developing understanding through A. in relation to the goal. It contrasts on the one hand with blind stumbling solutions and on the other with sudden clearing of confusion.

Gradual Analysis as a Means of Changing Direction

In C.K.'s case the absence of S.R. results probably from the fact that he does not have to change his direction at any point. The question occurs to us, "Can we find changes of direction produced by G.A.?" F.D.'s case, following, is an example: It is also very interesting because its character is decidedly zigzag, including a large amount of M. Yet we cannot consider it a "blind" T.E. solution because the progress depends on A. rather than on M.

F.D. was told at first to make "something" with the pieces, but after a short time, as indicated on the protocol, was told to make the T.C. This variation in directions is not sufficient to affect the rest of the solution.

Protocol 21, F.D. on T.C.

Mixed Presentation

Moves	*Remarks*
1. Picks up C, A, D_1, D_5 in turn (Obs.).	1. Anything? A definite shape? Nothing seems to fit.
	2. Compare relative lengths (A.).

Digitized by Google

2. Makes a little cross of 2_c (see diagram IV)
3. Fits several edges of same size together at random.
4. Moves B_s and D_s.
5. Got 4A together as a sq. (later broken up and not recognized at end) (See diagram I).
6. Collects similar ones (M.).
7. Gets E 1, 2, 3 and is stuck (See Illustration 3, p. 77).
8. Measures D_s to E 1–2, but doesn't get square possibilities of D (See Illustration 3, p. 77).
9. Tries little triangle with E 1, 2, 3.
10. Pulls E apart and A. Makes more crosses.
11. Pushes crosses together. puts D_s in center (Effect of wrong direction).
12. Makes quite a few moves with B1–4 around the little cross B5. Gets a big cross, pulls them apart. Measures approximate widths of B and D with hands (M.).
13. Builds up a large sail boat.
14. Makes an oblong of 4 Bs (See illus. p. 77).

3. Looks like a lot of different crosses (Obs.).
4. Only 1 E_s—how peculiar.
5. Can you make a complete solid figure? I like to make crosses. It's full of potential crosses, three already.
6. That's nice. That's the iron cross (internal swastika).
   [O told to make one large cross at this point.]
7. Assemble my data.
8. Let's see. This is queer—(E 1, 2, 3).
9. Frustrated again.
10. — One track mind, started crosses and must continue them.
11. Not to destroy too much till I get a better idea. D_s should be the center (A.).
12. Same general ratio. Then 4 alike and 4 more, and B_s. Must that be used too? Then it can't be anything simple (A.).
13. Must be built with others and it as a center. Cannot see what will fit it.
14. Have to find out how big it is, roughly about 4 big ones—should be about 2 plus times as wide (A.).
15. Don't see why when I've got crosses together—is there some way to destroy them? Trying to get 2 widths of one arm. There are about 2, but what good does it do me.
16. Oh, how did I get so unsymmetrical—disgusting.
17. Maybe that's the center. This isn't any good.

Digitized by Google

15. Restless-head on hand. Studies pieces, takes apart and puts pieces around B correctly.
16. Moved D_5 against B but didn't see the square possibilities.
17. Measured A against it on the diagonal but didn't see it.
18. Added D 1–4 to D_5 as cross. Makes D (M.).
19. Moves several pieces, trying them in relation to D_5 (See Illus. op. p. 77).
20. Suddenly got it by chance and immediately filled in triangles (R.).
21. Works with odd pieces of E but can't get them all.
22. Gets E1, 2, 3 and leaves it.
23. Works with C and A but makes crosses and then tries to use one part on each side of B (M.).
24. Finally gets them and returns and finishes E.

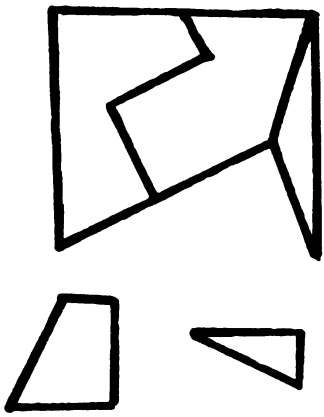
18. Like the looks of that. Can see bottom isn't going to fit altogether (A.). Square looks about the right size for top of one arm.
19. It ought to be obvious that D_5 won't fit anywhere except in the middle, but dimensions more than square.
20. Saw the dimensions this time. Very pleased about that. Now looks as if the whole were built up of 4 or 5 squares, so that is the thing to work on (A.).
21. No, no, Oh can I cry? Still I like the system of squares.
22. Now how to get width of arm.
23. Tch, tch, tch, did I say these make a square.
24. Well, if not opposite sides, see if they will combine. More fruitful. Makes C by recognition.
25. E. "How do you feel about it now?" O. "I don't know, not home yet. Didn't remember A. It was a stumbling block."

Retrace:

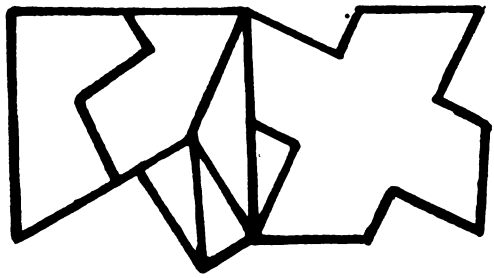
First wanted to use crosses—lazy. Discouraged and began to think about the approximate width (two times plus). Then fooled aimlessly till made the square of B. Knew the cross has to go with these. Only one o.k. and then 2, and as soon as that was so had it figured out about the width. Couldn't use D_5 because too large for width; then shoved it around and the little triangles fit in. What held me up was the mistake in width. E. "What is thinking?"—"It is really planning instead of aimlessly putting pieces together. If I didn't think I would put pieces together for hours. It's really planning, finding a key. Chief thing is the width of the cross. Could compute the areas to overcome the obstacle and measure by distances. Drew conclusions."

Digitized by Google

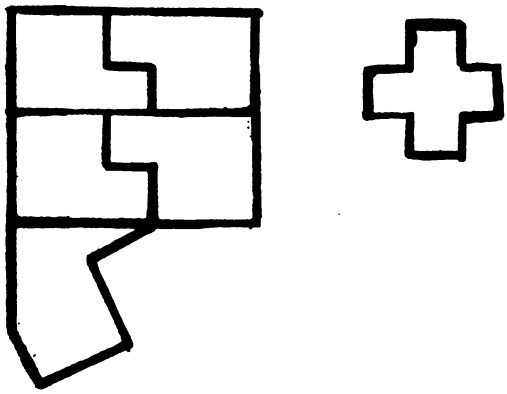
F.D. Protocol 21



Illustrates Moves 7. Also shows the "illusion" involved in placing E 4, 5. The space seems too large for them.



Illustrates Move 14 leading to 15



Illustrates Moves 18 and 19 leading to 20

Conclusions from Protocol 21:

1. The solution has been worked out very gradually by means of a series of observations and inferences in relation to the goal.

Digitized by Google

His first progress is made when he begins to group his pieces as to similarity and make observations about them in relation to his goal. (This O does not immediately and directly go about analyzing the goal, but that he has done so by implication we can see in his remarks, *e.g.*, that D_5 must be the center.) He sees that E 1–2 go together but when he cannot add other pieces to advantage drops to M. for a while. Then he pulls himself together again, and begins to make rough estimates of the needed size. This of course is decidedly analytic and leads him eventually to B and D completion.

2. The rôle played by M. is more blind and less effective than that in procotol 20, p. 74. The blindness is partly due to the set for crosses and partly to the fact that he uses M. when he cannot see his goal clearly, as after move 7. However, it also has another rôle here, which is more useful. It helps him build the squares once he has decided to try for them. It also helps him in his use of measurement.

3. At remark 20—when he gets Puzzle D—we have what resembles S.R., but his attitude and feeling about it show a difference (see his retrace). Even at 25 he says, "I don't know—not home yet," and at move 23 tries to use part of Puzzle C on each side of center square—a different hypothesis entirely.

4. The rôle of experience. The necessary knowledge factors are not ready and cannot therefore be marshalled quickly because he has not had the square-making experience. S.R., therefore, is out of the question. The scheme of a five-square cross, even when O adopts it, must remain a hypothesis, for it has to be filled in by further information not yet available, so that O does not have that sense of having virtually reached the goal. He holds a new hypothesis but he cannot jump to the conclusion that he is finished as can the subjects who have already made the necessary squares.

5. His own feeling about his solution contrasts with O's feellings in S.R. He considers that "planning" has brought about the solutions, and "computing areas" has played an important part. That does not sound like blind T.E. nor yet like S.R.

H. SUMMARY OF TYPES OF SOLUTION

	G.A.	SR.	Not accounted for:
No experience 7	7		4, Set for squares transferred; problem not solved anew.
sq. making experience 21	1	13	1, Record lost. 1, Never finished. 1, Came in too soon and saw E arranging T.C.

Digitized by Google

The O who had experience but solved by G.A., failed altogether to recognize the material because it was presented as a series of small crosses.

The group without square-making experience may be divided as follows:

1. Number solving without change of direction 1
2. Number solving with change of direction involved, but passing through the turning points without any sense of discovery or completion 4
3. Number solving with change of direction but no special turning point, by groping their way rather blindly 2

The group with square-making experience, solving by S.R., may be divided as follows:

1. Number in which the background was developed very gradually during the long preparatory period 2
2. Number in which the background consisted chiefly in a rapid series of inferences and recalls made during the pause 7
3. Number in which the solution developed in two steps, one, by G.A. and one by S.R. (one showing "what" was to be done, the other "how") (transitional cases) 4

The first chart shows that no O without experience solved by S.R., while only 1 of 21 with that experience solved by G.A.

The divisions of the group signify, upon analysis, that these two classes cannot be distinguished as mutually exclusive.

I. The Rôle of Experience

Psychologists, generally, have attributed much of thinking to experience; gestaltists, on the other hand, minimize its importance. The present experiment, is, in a measure, a test of the rôle played by experience, because one group of subjects was given a definite kind of experience, that of making parts of the pattern, later to be used together, *i.e.*, squares, while the rest were given the final puzzle without this experience. Of course, all Os had certainly had experience with cardboard, and with crosses and squares, only not with this particular arrangement of them, so that we must be careful not to overdraw our conclusions. But it is nevertheless interesting and suggestive to note:

1. That Os *without* square-making experience were perfectly able to solve the problem by A.

2. Only those *with* this experience solved by S.R.

3. In S.R. the background and steps were supplied largely by experience.

Digitized by Google

4. In A. the background steps were supplied largely by inferences.

5. Hence the timing in the manner of emergence of the solution was different.

(a) When the necessary knowledge factors of the background were supplied by experience, O could see several related factors *at once* and the whole picture changed instantly.

(b) When they were supplied by inferences, O could see *one* step clearly at a time and the picture was changed gradually.

6. Both depended, in the final instance, on O's seeing the relations of these factors to the goal.

7. Recalled experience was of no use without seeing this new relation of the facts to the goal.

We may conclude that the specific experience, even though not necessary, plays an important facilitating rôle in the solution of these problems.

The two schools of thought can be reconciled. The gestaltists would insist that insight can take place only if O can see the whole field. One's ability to grasp the field is infinitely widened by experience. In fact it depends on experience wherever the problem is beyond O's apprehension span. Furthermore, our apprehension span would be extremely limited if it depended only on what we could take in with our senses at the moment. Experience increases it enormously. All this the gestaltist could accept. Koffka has said that a complex gestalt can usually be found to depend on simpler ones, and that these often owe their existence to experience. Wertheimer expresses a similar idea in saying that "experience changes the functional value of the parts." In our case, the material can be thought of as having been "gestalted" as squares in experience, thus making available a new functional value when the T.C. is being solved. For those to whom this grouping isn't accessible the task is much harder, though not impossible. One cannot say just what the implications would be for other material, but here the idea of a whole field of squares seems to come at once to the experienced, whereas for the inexperienced, the idea filters in gradually.

J. Summary of Results of Chapter III

1. We definitely find a method used in problem solving, which is best described as S.R. and which closely parallels the usual descriptions of sudden insight. It is unique both to the O and the E.

2. This process occurs occasionally—often enough to be thought

Digitized by Google

of as one form of thinking but not enough to merit the label of "the thinking process."

3. When it occurs it comes with an onrush that makes it seem very sudden—an "out of the blue" experience. But it can always be found to have developed gradually. The suddenness must be regarded as due to the concealment of the background. It does not bring in a new *kind* of process.

4. The realignment occurs before the pieces are moved so that we can speak of S.R. as foresight.

5. Usually a rather short very quiet pause occurs just preceding the S.R. This ends with explosive elation or relaxation and relief.

6. While the essential feature of the S.R. pattern never changes, involving always a sudden subjective readjustment of the field, the details may vary considerably. Sometimes the background develops slowly, sometimes very rapidly just before the S.R.; sometimes O jumps to conclusions, sometimes he verifies first, sometimes shows great excitement, sometimes but little.

7. Another method of solving is by G.A. which consists of a series of inferences based on observations of the material in relation to the goal combined with some T.E.

8. In G.A. the steps leading up to the final solution are clear and understood by O in relation to his goal.

9. G.A. may involve a change of direction but need not.

10. When both S.R. and G.A. involve a change of direction they differ in that in S.R. the confusion clears all at once; in G.A. gradually; also in S.R. the error curve ends in a sharp drop while in G.A. it is step-like; and, again, in S.R. the background is concealed, in G.A. revealed.

11. Experience with the material in partial patterns (*i.e.*, squares) is not necessary to solution, but is facilitating. No O solved T.C. by S.R. without experience; only one O with experience solved by G.A.; most of them by S.R.

12. The function of experience with the partial patterns seems to be that of widening O's apprehension span. Unless O sees the new relation of his experience with squares to his goal, however, experience is useless.

13. Although some experimenters, like Duncker, regard each step in G.A. as an "insight" and consider suddenness unnecessary to the term, it seems worth while to give two separate names to two such different methods of solving. If we call one "analysis," and the other "sudden reorganization" we succeed in describing the process briefly but adequately, and yet avoid controversy and confusion.

Digitized by Google

14. On the other hand since the same fundamental processes, observations, recalls, seeing relations, and attention to the goal, are used in both, and since we find "transitional" cases, we may conclude that instead of being mutually exclusive, these types of solving are points on a continuum.

15. We have a series varying in degrees of clearness as to goal, from T.E. through S.R. to G.A.

16. Orientation to the goal and seeing relations must be part of any problem solving. These are included in the blindest T.E. But neither A. nor S.R. adds an essentially new *kind* of process.

Digitized by Google

CHAPTER IV

GENERAL CONCLUSIONS

These results lead inevitably to the conclusions that:

1. Problem solving in human adults is never completely blind or random, although O may proceed to his goal by manipulating the material without seeing ahead the relation of his moves to the goal. At the worst he *recognizes* it by hindsight.

2. On the other hand, it is, except in the simplest cases, to some degree exploratory, and always requires some manipulation, if only for verifying a correct hypothesis.

3. It is not that a new kind of process, that of seeing the relationship of the material to the goal, enters in at the level of so-called "insightful" thinking, but that that process was there in nucleus, though but vaguely, from the beginning, in the "blindest" variety of trial and error. Whether this is an independent process or is based genetically on trial-and-error or conditioned response, is not established.

4. One can distinguish three main types of solution, which can be considered as three "forms" of thinking, whose characteristics are sufficiently different to warrant the application of three separable

T.E.	*S.R.*	*G.A.*
1. "Blind" groping	Groping suddenly stopped	No groping but a gradually developing understanding
2. Hindsight	Sudden foresight	Foresight
3. Confusion till the last moment	Confusion suddenly cleared	Cleared step by step
4. Hopeless feeling	Excitement, elation, sometimes relief	Satisfaction
5. Aim—to match pieces	To look for wholes or interrelations	To satisfy goal needs
6. Attention to goal distant, diffuse	Attention not centered on goal	Attention concentrated on specific goal needs
7. Attitude not definite, but wandering, haphazard	Passive, receptive	Active, directed search
8. Error curve irregular, may not drop out after solution; transfer poor	Curve irregular, then sudden drop; transfer good	Error curve step-like; transfer good
9. Manner baffled	Baffled, then suddenly well organized, efficient	Calm, well-organized

Digitized by Google

Digitized by Google